Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. IX. NEW YORK, SEPTEMBER, 1904. No. 7.

"COMPRESSED AIR"

Published Monthly.

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"Compressed Air,"

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A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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VOL. IX. SEPTEMBER, 1904. NO. 7

Air in Hoisting.

Now that the air compressor is to be found in so many shops, the opportunity to take advantage of the varied uses of compressed air is frequent. An installation made for one purpose often develops several minor ones which, while not of themselves of sufficient importance to make an installation advisable, are able to add to the economies secured. This is in many cases true of pneumatic hoists. The possibilities of air under pressure for hoisting are unusual. This subject is dealt with at length in a paper by Mr. J. S. Lane, an engineer who has given much study to this subject. This paper is published in this issue through the courtesy of *Mines and Minerals.*

As a hoisting power, compressed air finds itself in competition with both steam and electricity. To claim that it is superior under any and all conditions would be absurd. It is, nevertheless, very true that in a vast majority of instances where compressed air is available it can be used to advantage. There are also instances where a compressor to supply air for that purpose alone will result in economies. It is chiefly, however, in the shop where air is on tap for other purposes that it may be combined, resulting in economy of power and improved service.

The utilization of compressed air for hoisting does not necessitate a new equipment. A varied line of air hoists has been placed on the market and offers many advantages. It has been proven, as will be noted in Mr. Lane's article, that it is often possible to substitute compressed air for steam without making any changes in the machinery, save cleaning up and repacking, perhaps. An installation expressly for compressed air means the investment of considerable money, and the conditions in a shop may make that inadvisable. Where it is possible simply to substitute air for steam, using the same machinery with only a few dollars spent for packing, it is a different proposition.

The facts, as presented by Mr. Lane, are of decided interest to even the small manufacturer, and the dealers in compressors and other pneumatic machinery may read them with profit.

New Ideas for Advertising.

Readers of COMPRESSED AIR will be interested in the rather unusual method which the Ingersoll-Sergeant Drill Company has adopted to secure new ideas for its advertising. While this publication has but one aim—to cover the field of compressed air and its practical applications—it is at all times glad to assist its advertisers in improving the effectiveness of their advertising. With that idea in view, we have agreed to assist the Ingersoll-Sergeant Drill Company in conducting its

competition and in receiving the suggestions.

The letter received from that company will probably best explain the details:

NEW YORK, July 14, 1904.

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26 Cortlandt Street,
New York:

Knowing your interest in every plan to improve the advertisements in your publication, we have taken the liberty of asking your co-operation in a plan which we desire to give a trial.

It is our intention to offer five prizes for advertisements best suited to the requirements of this company. Any stockholder or employe of a company, firm or individual using Ingersoll-Sergeant machinery or any one in the employ of the Ingersoll-Sergeant Drill Company will be at liberty to submit suggestions.

Each advertisement should be prepared for a particular trade paper, designed to fill the same space as the company's regular advertisement in that paper. Any of the following papers may be selected: *American Machinist,* COMPRESSED AIR, *Engineering Magazine, Engineering News, Engineering and Mining Journal, Granite, Mining and Scientific Press, Mines and Minerals, Railroad Gazette, Railway Age and Rock Products.* The excellence of the advertisement will be determined by the subject matter, its arrangement and its appropriateness for the publication for which it is designed.

The prizes will be as follows:

First prize	$25.00
Second prize	10.00
Third, Fourth and Fifth prizes	5.00 each

In addition, a prize of $10.00 will be awarded for the best and most original suggestion for keeping the name of the Ingersoll-Sergeant Drill Company before the public.

Selections will be made from the advertisements received, and they will be published. The final choice will be made from among the advertisements which have appeared in print. The competition will close November 1 and the awards will be made as soon after that time as possible. We reserve the right to copyright and use any of the advertisements submitted.

We would like your co-operation in receiving these suggestions, and, if you have no objection, will have them sent to your editorial rooms.

Trusting that we may hear favorably from you, we remain,

Yours very truly,
THE INGERSOLL-SERGEANT DRILL CO.,
W. R. GRACE, Secretary.

As this invitation has been accepted, suggestions should be sent to COMPRESSED AIR, 26 Cortlandt Street. The awards will be made by the Publication Department of the Ingersoll-Sergeant Drill Company.

Compressed Air in Hoisting.

It has long been known that compressed air forms a convenient and practical method of transmitting power to one, or a number of hoisting engines, particularly where water, or other cheap power is available. This method of transmitting power has until recently been of low efficiency and consequently wasteful of power, and has been attended with much difficulty from the refrigerative action of compressed air during expansion, causing the formation of frost and ice in the exhaust and cylinder of the engine. Recent improvements in compression and use of air have opened up a new, enlarged and profitable field for compressed air, of which we will speak later.

The simplest application of compressed air for hoisting is found in the pneumatic hoist, consisting of a vertical cylinder provided with a ring or eye bolt at the upper end by which it may be suspended (see Fig. 1). Working freely, but air tight in the cylinder, is a piston with a piston rod extending through a stuffing box in the bottom head and provided with a hook at the lower end. Air is led to the machine through a hose. When it is desired to hoist the load, air is admitted to the lower side of the piston by a suitable valve. To lower it the air is permitted to escape. Usually a three-way valve is used, but two globe or angle valves may be substituted, one to admit the air and the other to let it out. In case loads are to be lifted to the same height, an adjustable stop motion may be provided to close the air valve when the desired height is reached. Should the air leak out, the load may slowly descend. This has in some cases

been remedied by the use of a small oil cylinder with a by-pass valve that is open during hoisting and closed by the same motion that closes the air valve. The oil, not being compressible, sustains the load. As the load is lifted by the direct pressure of the air under the piston, knowing the air pressure available and the maximum load to be lifted, it is an easy matter to figure the required area of the piston.

Four, five and six-inch cylinders are the sizes most often used, and the lift is generally from four to six feet. Smaller sizes are made in special cases, and it is possible to use larger ones when required, but they are seldom built over 18 inches diameter by 10-foot stroke. One favor-

FIGURE I.

able point in such a hoist is the fact that the machine, swinging on its eye-bolt at the top, readily adjusts itself to a straight line between the point of suspension and the lifting hook, thus lessening the friction and doing away with the danger of bending the piston rod. Should there be lack of head room the cylinder may be placed horizontally (see Fig. 2). and supported in a convenient manner. A chain leads from the piston rod one-quarter way around a shieve, down to a hook to which it attached the load. By using a stiffer piston rod in compression carrying a shieve on the end, half way around which a chain passes, one end of the chain is attached to the cylinder and the other leads back over the cylinder and down over a stationary shieve to the load (see Fig. 3). By this arrangement the piston moves only one half as far as the load, but must have double the area required in a direct hoist. By using more shieves the movement of the load relative to the piston may be further multiplied.

A Telescopic Air Lift.—Air lifts for low head room have been made with two cylinders, one sliding within the other, each cylinder being required to give only one-half the desired lift. The annular area between the inside and the outside cylinder is somewhat greater than the area of the inner cylinder so that in hoisting the inner cylinder will always be hoisted to the top before the piston within it begins to rise.

Air cylinders may be bolted to the mast or main upright of a crane, or attached to the job, and used for operating the crane by suitable shieves and chains, either with piston and load moving at equal distances or with shieves multiplying the motion.

Figure 4 shows a novel application of air to an existing crane, taken from COMPRESSED AIR. The air cylinder is bolted to the upper part of the mast and by the use of a shieve the motion of the lifting hook is double that of the air piston. One end of the rope passes over the lifting shieve down to the crane hook, the other end of the rope is attached to the winding barrel of a hand windlass on the mast. This windlass works on one end of the rope, so we have either a hand or air crane at will.

Figure 5 shows a foundry crane originally made to be operated by hand, but to it has been attached an air motor without changing the original gearing in the least; so it may at any time be operated either by air or hand. The motor is reversible and of the direct-acting piston type. Its economy in the use of air is best illustrated by stating that the air compressor is stopped at the end of the day's work with the air receiver (which in this case was an old boiler) charged, and sufficient to draw all their castings in the evening without running the compressor. For many purposes this type of motor is preferable to a straight lift hoist, because it is not limited in the height of lift, uses air only in proportion to distance the load is lifted, holds the load in constant po-

sition, does not jump up when part of the load is removed, as in pouring molten metals, will do delicate mould work safely and can be placed in close quarters where a cylinder hoist could not be used. This system is admirably adapted for use in converting a hand crane into a power crane.

Traveling Cranes up to 500 feet long are being successfully operated by com-

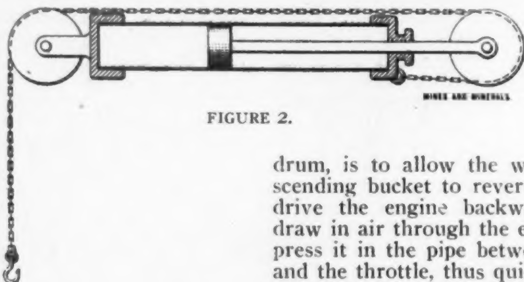


FIGURE 2.

pressed air led to them through hose that is suspended in loops supported on wheels traveling on a light overhead track.

Air Hoists in Mine Repair Shops.—Nearly all mines now have compressed air available that can be used to advantage in the repair shop for hoisting as well as other uses. It may be used in the simple air hoist already described and in various

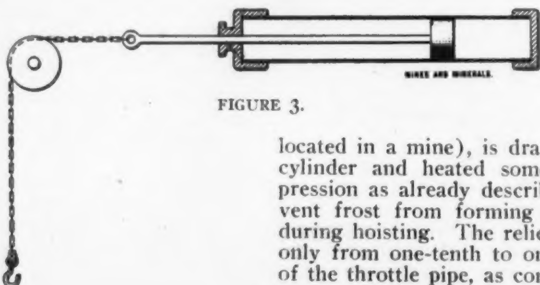


FIGURE 3.

other hoists all the way up to a traveling crane capable of lifting a mine locomotive.

In hoisting engines air may be substituted for steam in many cases with advantage. No change is necessary in the engine, although it is sometimes advisable to reheat the air to prevent freezing. It is desirable that the valves and pistons be tight, and that the clearance be small. In substituting air for steam, inasmuch as many steam hoisting engines have more clearance than they should have, it is well to reduce the clearance by riveting an iron plate on the inside of the cylinder heads.

One method of *preventing freezing* in the cylinders and exhaust of a hoisting engine driven by compressed air, in case the weight of a descending bucket, skip or cage is available to reverse or back the drum, is to allow the weight of the descending bucket to reverse the drum and drive the engine backwards. This will draw in air through the exhaust and compress it in the pipe between the cylinders and the throttle, thus quickly stopping the lowering unless the air be allowed to escape, which it is permitted to do through a relief valve located between the cylinder and throttle. This relief valve is simply an easy quick-opening lever valve by which the rate of air escape can be regulated by hand; thus governing the rate of lowering at will without the use of a brake. If the air either of an engine-house or of a mine (in case the hoist be located in a mine), is drawn through the cylinder and heated somewhat by compression as already described, it will prevent frost from forming in the cylinder during hoisting. The relief valve need be only from one-tenth to one-fifth the area of the throttle pipe, as compressed air escapes into the open air with great rapidity. Little care need be used to lessen the friction of the air in the escape pipe. A link motion hoist with a pair of 10 by 15 inch cylinders and a 4-foot drum was in use with satisfaction for some years underground at the Chapin Mine, Iron Mountain, Mich., operated in this manner by compressed air and without a sign of freezing. In case of a light bucket the link

can be used to start the engine lowering. When the link is reversed again the engine becomes a compressor. The rate of lowering is regulated by the relief valve, which is closed to stop the empty bucket

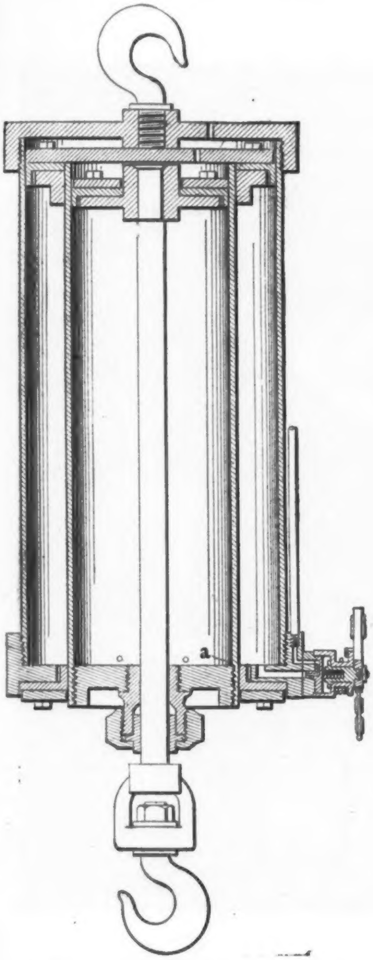


FIG. 4—TELESCOPIC AIR HOIST.

or skip at its landing point. It is then only necessary to open the throttle to begin hoisting.

It is sometimes desirable to use a small hoisting engine that cannot be run backward. If inconvenient to reheat the air the exhaust port may be kept clear of ice by a small jet of water arranged to play either directly into the exhaust opening. Better still, a small pipe may be tapped into the exhaust passage so that the jet will play into the throat or exhaust opening under the valve. This cold water is warm enough to cut and keep out the ice. The same device can be used in the exhaust of a "steam pump" or of a diamond drill engine driven by compressed air.

Hoisting engines especially designed for the use of air should have small clearances and extra large exhaust ports and pipe, although the necessity for the latter may be done away with by reheating the air near the engine to be driven. It requires but little heat to effect a decided saving. One-eighth of a pound of coke per horsepower per hour will raise the temperature of the air to 366 degrees if properly applied and effect a saving of from 25 per cent. to 35 per cent., besides doing away with all danger of freezing. Care should be taken to reheat the air near where it is to be used and the pipe should be covered between the engine cylinder and the heater. While it requires but little heat to raise the temperature of the air, it loses the heat easily. Where live steam is available it may be used for reheating air. Any good form of feed water heater may be used providing that it has ample heating surface and free passage for the air. When using fuel for reheating, the grate and the fire can be small, but there should be ample heating surface, arranged so that the cold air enters at the point of lowest temperature and leaves from the hottest part of the heater.

Advantages of compressed air in hoisting are greatest in cases where one modern, central power air compressing plant can be used to drive a number of hoists, large and small, located so far apart as to require one or more boilers at each hoisting station, involving a supply of fuel and water for each and the disposal of ashes. A number of such boilers scattered about a mine or quarry working intermittently, sometimes not called on for steam for hours and at other times overworked, are very wasteful of fuel and seldom give an average of efficiency of over three or four pounds of water evaporated per pound of coal. On the other hand, a first-class boiler plant at a central power station can be made to give efficiency of

eight or ten pounds of water per pound of coal. A hoisting engine driven by air under these circumstances is ready for instant, continuous service at full power and speed, no time being lost in working out the water, or in quickening the fire in case it has become dull, and no loss of steam from the safety valve in case of stoppage of the hoist with a hot fire under the boiler. Small boilers give trouble from freezing of connections at night, on Sundays and holidays, and require banking of fires, or keeping them up at a cost that is a large percentage of the actual running expenses of these particular hoists.

In mining and quarry work it often happens that demand for certain sizes or quality of product renders it desirable to lay up some hoists and perhaps work others beyond the capacity of the boiler. Air is much more flexible than steam and lends itself to help out in these emergencies. The points mentioned are not theoretical but practical and were brought forcibly to the writer's attention recently while inspecting the working of the central air

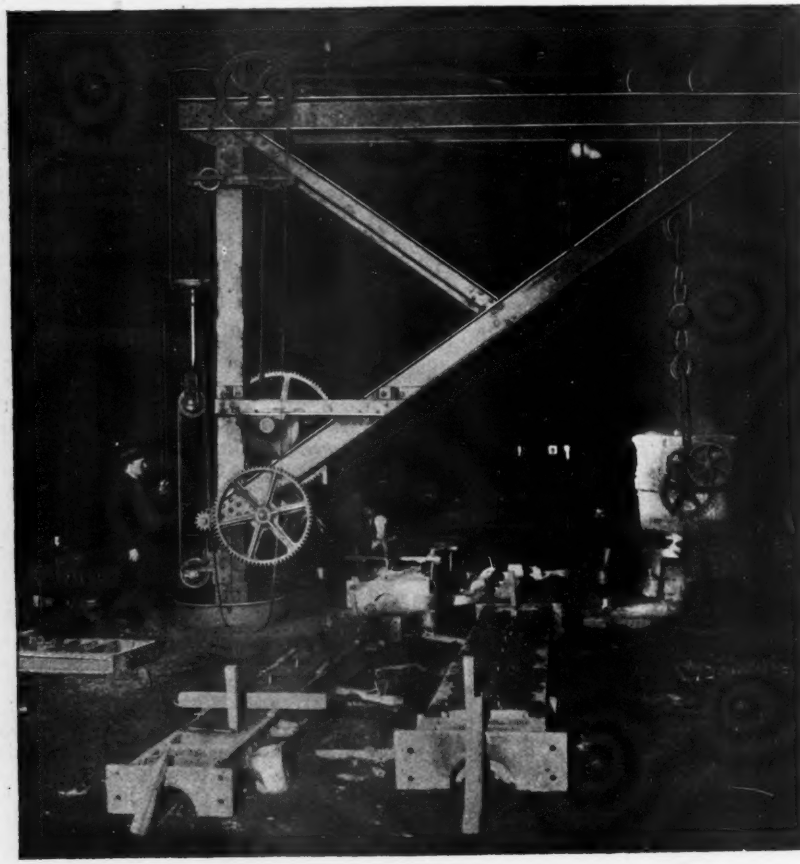


FIGURE 5.

plant installed at No. 6 quarry of the Cleveland Stone Company at North Amherst, Ohio. This, without doubt, is capable of producing the largest amount of air per pound of fuel of any steam plant in this country, and of a quality so dry that there has been no trouble from freezing through the past unusually cold winter, although there are several miles of pipe lines all in the open air, and some of the hoisting engines are located nearly a mile from the central station. It is a popular fallacy that compressed air freezes; in reality it is the water in the air that freezes and, if the air is made dry, which is perfectly practicable, there will be no freezing in the pipes.

When this quarry was operated by a large number of steam boilers it would take about thirty minutes in the morning to get into full working shape with the hoists, channelers and drills, and little work was done the last fifteen to thirty minutes before quitting time, especially in the winter, owing to getting ready for leaving the boilers for the night. With the use of air, work begins on the blowing of the whistle and is in full swing within five minutes, as indicated by the number of revolutions made by the compressors. It continues up to the blowing of the whistle at quitting time.

A large number of derricks are operated by the hoisting engines, all driven by air. Quite a number of the hoisting powers are driven by single-cylinder engines, average size 12 by 16 inch, the power being transmitted by belts and clutches to the drums. In one case a duplex 7 by 12 geared engine is used to drive derrick powers. In each case the air is reheated before entering the engine. Different forms of reheating are used, the most simple and effectual is

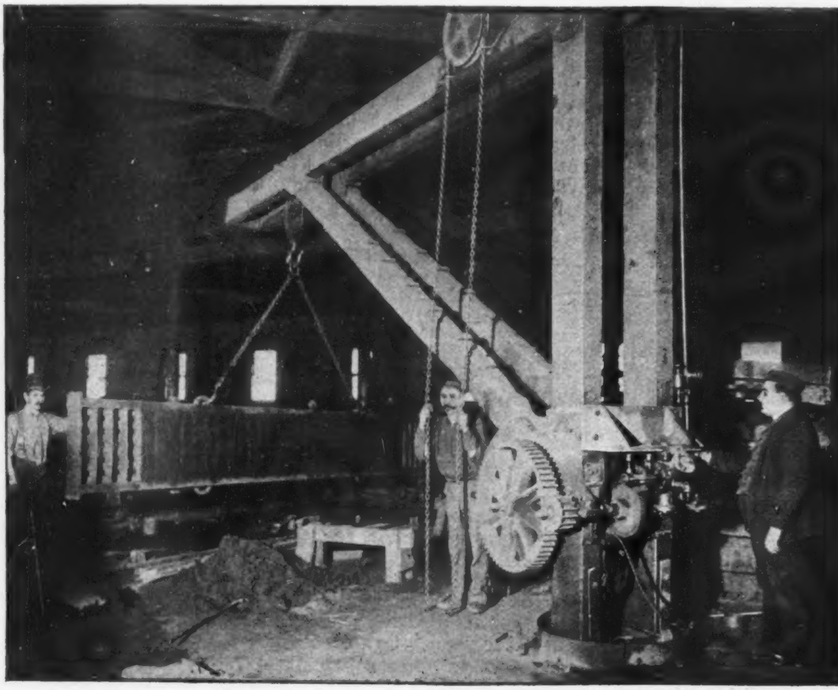


FIGURE 6.

shown in Figure 6 and consists of a brick fireplace *a*, from 7 to 16 feet long, according to requirements, about 2 feet wide and 36 inches high, containing coils of 2-inch gas-pipe made up with return bends, through which the air passes. A small grate *b*, only 12 by 18 inches, at one end of the furnace, supports a fire made of gas-house coke, one to two bushels lasting a day of ten hours. Coke is fed in through an opening in the top of the furnace, covered with an iron plate or tile *c*. The chimney *d* is usually a pipe only 5 or 6 inches in diameter. The air is heated from 300 to 400 degrees, giving a gain in efficiency of 20 to 35 per cent. In a few cases where steam boilers used for other purposes are near old feed water heaters have been utilized for reheating air, by putting steam into the tubes, the compressed air passing through the heater around the tubes. In some other cases the steam boiler formerly supplying steam for the plant still remains in place, and is used for an air receiver, thus adding to the air storage capacity. A slow fire is maintained on a portion of the grate near the fire door, not hot enough to endanger overheating the boiler, but still supplying sufficient amount of reheating of the air to give the desired results, burning about three bushels of soft coal slack per ten hours.

Hoisting engines run intermittently and consequently are less liable to freeze than other engines. It may be mentioned here that the reheater shown in Figure 6 is used in connection with a 14½ by 24 inch mill engine, making 100 revolutions, 24 hours per day, driving five gangs of stone saws. The engine is fitted with an adjustable cut-off, cutting at one-quarter stroke and indicating 96 horse-power, is located about 2,500 feet from the central power station, and the pipe is on supports in the open air.

The fact that more and better work is now being done at No. 6 Quarry than could have been done before the installation of air, and using only from one-quarter to one-third the coal before used, speaks volumes for the designers, the builders of the plant, and the use of air, and the enterprise and foresight of the management of the largest quarry in the world.

One of the largest compressed air plants in the world is located at Iron Mountain, Mich., and furnishes compressed air for the Chapin Mine. It consists of four large turbines under 56-foot head, driving through gearing two pair of compressing cylinders 32 by 60 inches, one pair of cylinders 34 by 60 inches and one pair 36 by 60 inches (eight cylinders in all), compressing air to about 65 pounds per square inch into a 24-inch pipe leading to the mine, three and one-half miles away. This pipe was made larger than necessary to provide for increasing the air plant if desired. It also acts as a receiver and delivers the air at the mine practically without any drop in pressure. The air is used for rock drills and mine pumps, a machine shop engine, 10 by 30 inches, and a saw-mill 18 by 24 inch engine. It also operates four pairs of large Corliss hoisting engines, one pair of which have 30 by 60 inch cylinders, one pair 20 by 72 inch, one pair 32 by 72 inch and the remaining pair 20 by 48 inch. The 20 by 48 inch and the 32 by 72 inch hoists operate flat rope reels on the engine shaft. The one pair of 30 by 60 inch cylinders operate a pair of first motion conical drums. The drums are mounted directly upon the engine shaft and are 10½ feet in diameter at the small end and 14½ feet in diameter at the large end, operating a pair of vertical cages with a net load of 2½ tons of ore. The ropes are 1⅜ inch diameter. Seventy-two thousand tons of ore can easily be hoisted from each shaft per month from an average depth of 800 feet.

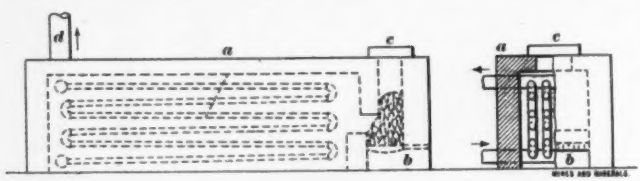


FIGURE 7.

The main throttle consists of a 10-inch balanced double beat valve, from which an 8-inch pipe branches to each cylinder. When these engines were first started

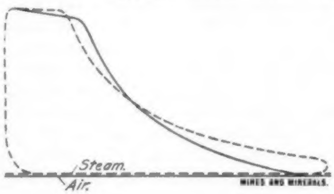


FIGURE 8.

some difficulty was experienced through the formation of ice in the exhaust ports and several exhaust valve stems were twisted off. It was found that a ½-inch steam pipe allowed to discharge into each cylinder furnished sufficient heat to ob-

The fourth plant consisted of the 32 by 72 inch first motion Corliss engines, with flat rope reels each 8 to 16 feet diameter. The ropes are ⅞ by 8 inches, handling two vertical cages capable of lifting a net load of 10 tons from a depth of 1,400 feet. Reheating of the air in these plants has lately been introduced with good results.

Hot Water Air Reheater.—Figure 7 shows a reheater recently installed at the Chapin Mine, a hot water heater *a* being used in connection with an air heater *b*. The latter is very similar to a feed water heater. The hot water ascends from the heater into an expanding tank, circulates through the air heater, imparting its heat to the air, and returns to the heating stove. Valves are provided by which the air can be shut out of the heater at will.

There are no limitations as to the size of hoisting engines that may be run by

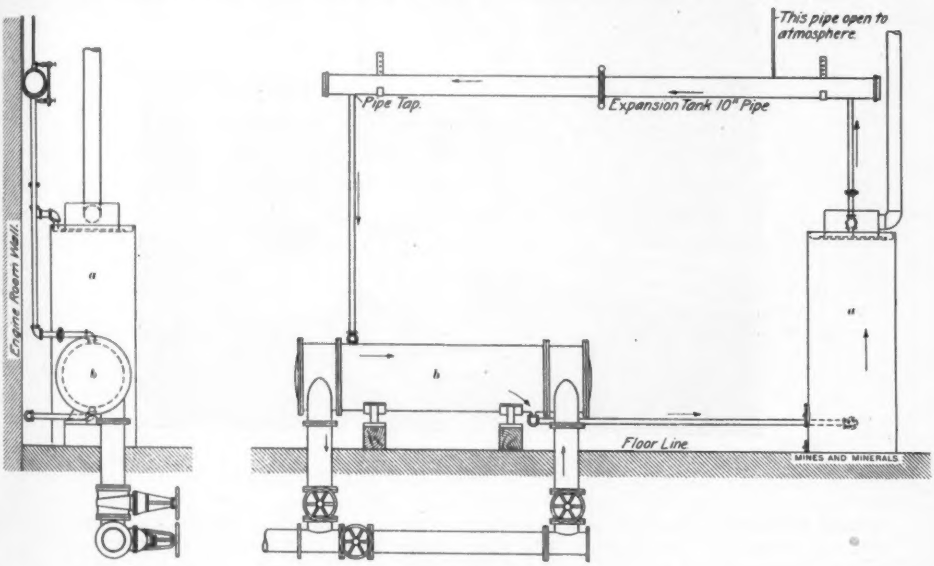


FIGURE 9.

viate the freezing of the valves, although the exhaust passages were still covered with white frost. An indicator card showed a little later cut-off than when using steam, and also showed a very rapid drop of the expansion line, due to the refrigeration taking place in the cylinder during expansion.

compressed air. It is simply a question of correct proportion between the compressing plant and the various uses to which the air is put.

Indicator diagrams taken from the same engine under similar conditions of load and speed are slightly different. Figure 8 shows a pair of such diagrams, taken from

a Corliss engine, the full line being taken while driving with air, and the dotted line when using steam. It will be noted that the line *a*, commonly called the steam line, at the top drops slightly in the case of air. This was probably due to the air cooling upon entering a cold cylinder, the air being reheated very slightly in this case by the ½-inch steam pipe already mentioned. The expansion line *b* with air drops faster than with steam, mainly due to the refrigerating effect of expansion, and partly from the fact that in the case of steam the expansion line is higher at the termination through re-evaporation of wet steam than it otherwise would be. It will be noted that the point of cut-off is a little later when using air. The effect of reheating would be to bring the air and steam lines and point of cut-off nearer alike. While the comparison of the lines on this card would be in favor of steam, there are many points to be taken into consideration that may more than off-set the facts shown in this diagram. Among these points, mentioned elsewhere in this paper, is the comparative lack of economy of many small scattered boilers as compared with a central boiler plant, cost of labor and danger of freezing, to which we may now add safety, comfort and economy of operation in the use of air as compared with steam in the case of deep quarries.

There are many quarries from 100 to 300 feet deep, and in their case it becomes almost an underground proposition. In some of these quarries boilers are located in the bottom of the quarry, with smokestacks reaching only half way to the surface. Derricks are also located in the bottom of the quarry to handle the blocks of ten or fifteen tons in weight which are dragged from under the hanging wall and swung around within reach of the derricks on the bank or surface at the quarry. The exhaust steam from the derrick engines, mingling with the exhaust steam from the channelers and drills, and intensified by the smoke from the underground boiler chimneys, fills the quarry, especially on "muggy" days, with a fog so dense that a lighted torch ten or fifteen feet

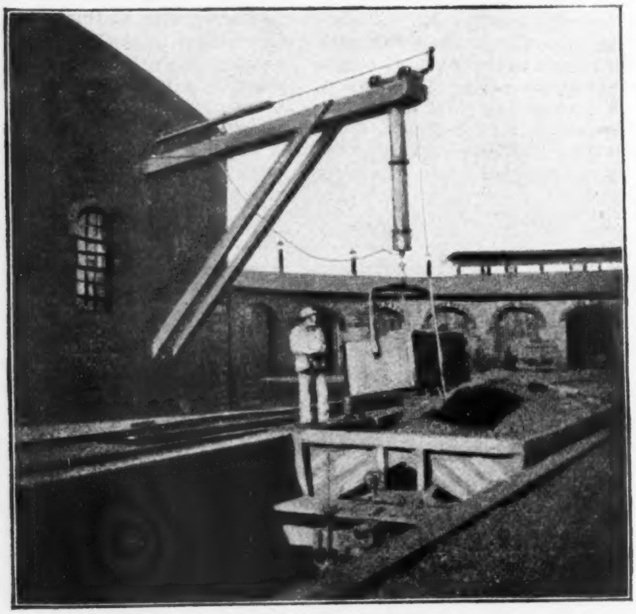


FIG. 10—AIR HOIST IN OPERATION.

away cannot be seen. The workmen cannot work in comfort, nor to the best advantage, and a satisfactory superintendence of the work by the foremen and superintendents is impossible. The exhaust steam is constantly condensing on the cold walls, especially in winter, forming ice, the falling of which is dangerous, and drippings which are uncomfortable. While in the summer the humid heat of the steam vapor is calculated to enervate the men. Frequently one-half the amount of water pumped out of these quarries at quite an expense comes from condensed steam. This water is not of a quality that can be used in the boilers, and a new supply must be piped down into the quarries for them and the quarry water pumped out.

While some of these matters seem foreign to our topic, "Compressed Air in Hoisting," they are mentioned here because of the fact that the introduction of compressed air into such quarries cleans up the air and remedies all these adverse conditions. Of course the air would be used not only in the hoists, but in the other machines. Even in open quarries only 100 feet deep steam and smoke from the hoist and machines frequently impede the work.

Ventilation.—Compressed air, exhausted into a mine from hoists, drills, pumps and other machines, adds materially to the ventilation, especially in iron, copper, gold and silver mines, where it is unusual to find ventilating fans. The air is exhausted into the working rooms and headings where it is most needed.

In case of *deep hoisting* permitting of long runs, cross-compound or double tandem hoisting engines may be used with high economy by reheating the air previous to its entering the high pressure cylinders, and also reheating between the high and low pressure cylinders. The reheating may be done in one heating stove containing the requisite number of separate coils, the air first being heated in one set of coils, doing its work in the high pressure cylinders and, after going through the other coils of the stove, doing its work in the low pressure cylinders.

In conclusion, space forbids going into details or even mentioning many interesting facts regarding compressed air in hoisting. The state of the art is rapidly advancing, and the writer will make two points in the line of prophecy.

First, that it will soon be practicable to operate a hoisting plant by compressed air with all the motions entirely automatic, the brakes released, the engines started, the throttle closed, the brakes applied, the skip dumped and stopped at the right point and after the proper interval, the same repeated, all automatically, with greater precision and regularity than can be done by hand, leaving the engineer free to look after the plant in general.

The second point of prophecy is that greater economy in reheating of air will be brought about by internal combustion, *i. e.,* a small amount of fuel burned in compressed air just before using.

J. S. LANE.

The Corrington Alternate Quick-Acting Brake System.

A solution of the difficulties attending the operation of long trains with powerful locomotives due to the combined action of the ordinary quick-acting air-brake and the recoil of the draft gear, which causes the frequent break-in-twos, seems to have been found in the combination of the automatic air-brake and a straight-air equipment on the locomotive and tender. The Westinghouse Air-Brake Company, some years ago, devised a combination of the two systems of air-brakes, known as Schedules S-W-A and S-W-B, which has been applied, to some extent, on the Canadian Pacific, the Colorado Midland, the Soo Line, the Northern Pacific and a number of other roads with marked success. Last year a committee of the Car Foremen's Association reported on the causes of trains parting, and one of the principal causes was attributed to the release of brakes at slow speed without proper resistance on the engine or on the head end cars. It was recommended at the time that all engines in road service be equipped with straight air in addition to the automatic quick-action air-brake, or, if this does not meet with entire approval, that trainmen be required, where slow-downs are made and where the speed is not to exceed eight miles per hour, to bring the train to a full stop, or to set up about six retaining valves on the head of the train, or set at least from four to six

hand-brakes. The application of straight air to the locomotive is recommended as the preferable method of overcoming break-in-twos from this cause, as conditions will sometimes arise when the attention of the head brakeman will be required at some other part of the train than or set up a few hand-brakes. A paper which was read at the Traveling Engineers' Association meeting last September gives the gist of the replies to a circular of inquiry sent out to all the roads using the combined straight air and automatic brake. All of the roads answered unquali-

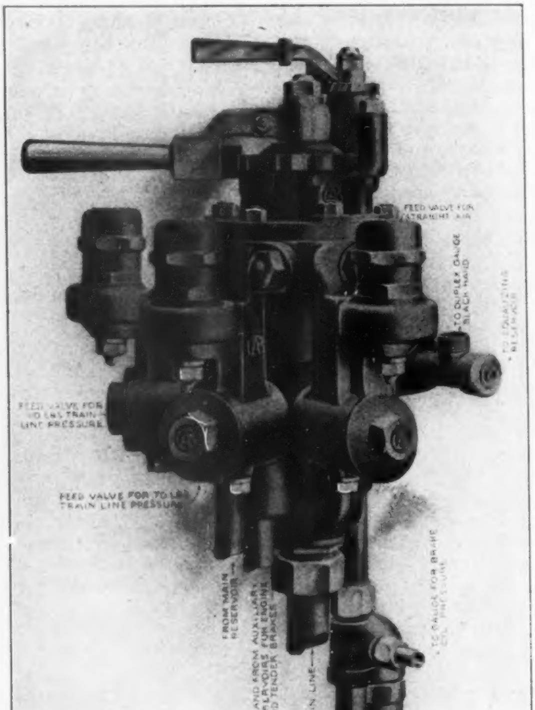


FIG. I.—CONSOLIDATED ENGINEER'S VALVE.

on the head cars when the release of the train-brakes will be necessary. The engineer, being permanently located in the right side of the cab while handling the engine, can more readily, with one movement of the hand, apply the brakes than the trainman can turn up the retainers, fiedly that they found many advantages in its use and no disadvantages, and that the cost of maintenance over the automatic brake, covering a period of from six to eighteen months, had been practically nothing.

On trains running over mountain div-

isions or on lines in which there are frequent humps and sags, the use of retaining valves assists materially in handling long trains without break-in-twos or runaways. On most mountain roads, however, extra precautions are taken to see that all of the brakes are in good working ceptionally long trains where frequent stops and slow-downs must be made. Unless the engineer is very skillful, break-in-twos are sure to result at water stations and similar places where the brakes are set too hard to carry the train up to the exact stopping point desired. Part of the

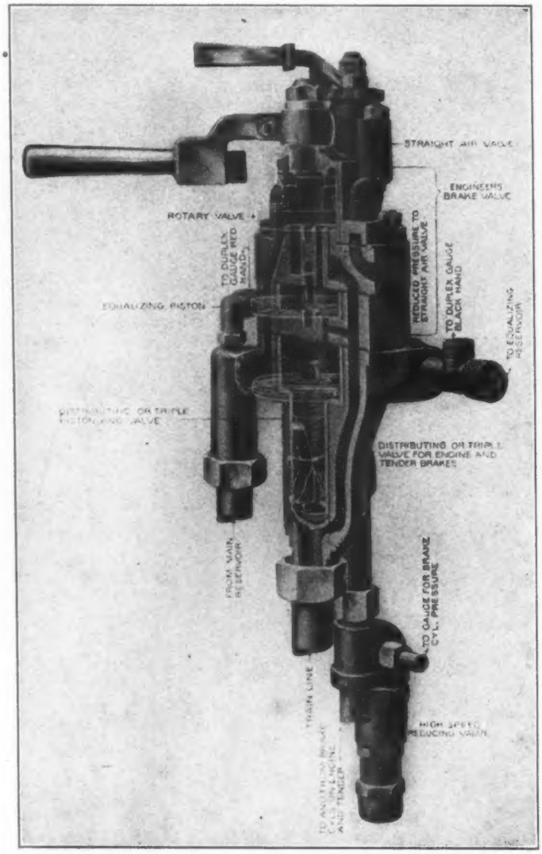


FIG. 2.—SECTION OF BRAKE VALVE IN RELEASE POSITION.

order and all the retainers set up before descending long grades, and the brakemen are usually on top of the cars with clubs to set the hand-brakes in case of an emergency. With these precautions, less trouble is experienced, perhaps, than on comparatively level roads handling ex- release is made when running at reduced speed. In switching service, it is almost impossible to handle a cut of cars with much speed with the quick-action brake alone without shock and damage to the cars and lading. The triple valve will not recharge the auxiliary reservoir between

very frequent brake applications, and as a result the engineer is compelled to make stops with the reverse lever. A quick release is possible with straight air, and if desired, the brakes can be only partially released.

additional system of piping from the straight air brake valve into the brake cylinders on the engine and tender, requiring an additional 36-inch hose between the engine and tender. Double check valves and a safety valve set at 53

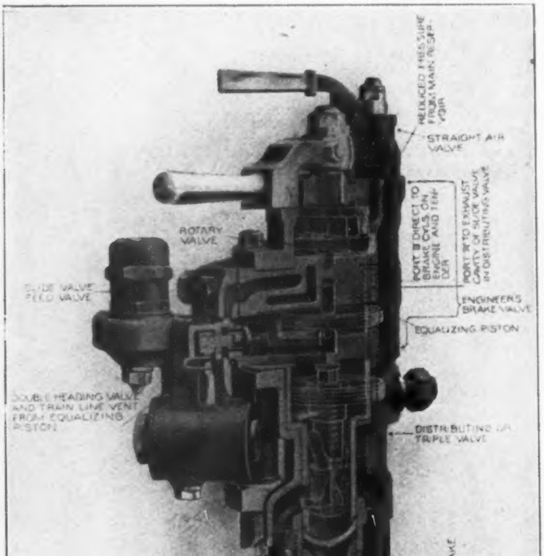


FIG. 3.—SECTION OF BRAKE VALVE IN SERVICE POSITION.

The Westinghouse combined apparatus for an engine and tender requires, besides the usual quick-action automatic apparatus, a connection from the main reservoir to a ¾-inch straight-air brake valve through a slide valve feed valve and an

pounds are inserted in the piping system to prevent the action of the straight air when the automatic is applied, and vice versa, and to guard against an excess of pressure in the brake cylinder over and above the limit to which the safety valve

is set. The straight-air brake valve is mounted in the cab near the automatic brake-valve, within easy reach of the engineer. The following description of the Corrington alternate quick-acting brake system, which is embodied in a consolidated engineer's valve, explains the action of the system of operating air-brakes on the train devised by the Corrington Air-Brake Company, and which accomplishes all the functions of the combined Westinghouse apparatus.

In the accompanying engravings, Figures 1 to 5 show the construction of the consolidated engineer's brake valve which is the essential piece of apparatus in this system. It combines in one piece of mechanism the triple valves for the driver and tender brakes, the high-speed reducing valve, the brake valve for operating automatic brakes on all the cars in the train, the feed valve and reversing cock, and all of the straight-air equipment applied separately in the Westinghouse apparatus, including the operating valve, double check valves and feed valve. These parts are all combined in such relationship to each other that each system is, at all times, independent of the other, and they are so designed that they can be operated together or separately. While operating one, the other may be brought into use at the same time without interfering with any of the automatic features. When used in connection with the usual quick-acting brake system applied to the cars, both an intermittent and an alternate continuous system is obtained, and the full control of the train is concentrated on the engine under direction of the engineer. The valve is designed to be applied in the present location of the brake valve, where it is isolated from injury, dirt and freezing. All of the apparatus, except the auxiliary reservoirs and brake cylinders, are removed from underneath the engine and tender. The only difference between freight or switching engine and tender equipment and passenger equipment, with the high speed brake would be the addition of the truck brake cylinder, auxiliary reservoir, and flexible connection. The reversing cock and two high speed reducing valves, in addition to the other apparatus, would be displaced.

The brake valve portion of the consolidated engineer's valve and approved existing types are very similar, with the exception that an additional feed valve and running position of the handle is provided. This permits the use of two train line pressures and allows the use of either, according to the position of the operating handle, making unnecessary the use of the present reversing cock, two feed valves and pipe bracket. The advantage of having two feed valves set at the same pressure in freight service, and in connection with long trains, as compared with one, as at present, is obvious.

The positions and directions of movement of handle for full release, running, service, lap or emergency, with the exception of the position for the extra feed valve mentioned, are the same as in valves of the Westinghouse type. The method of operating the equalizing piston with train line air also differs from, but is equal in efficiency and time to, existing types. Owing to the design of the port leading to the under side of this piston, as shown in Figure 2, it will not open after an emergency application or a heavy train line reduction when the handle of the brake valve is moved to full release position. By a special arrangement of ports the train line pressure is indicated by the black hand on the duplex gage when the handle of the brake valve is on lap position. Except for the adjustments of design to suit the triple valve portion of the consolidated engineer's valve, the main reservoir air has access to, and the train line air to and from the brake valve in the usual manner.

For convenience in double-heading, and in order that the automatic features of the brake may be maintained on the second engine, a small rotary valve is provided at the termination of the outlet of the train line from the equalizing piston. When double-heading it is only necessary to close this valve and place the handle of the brake valve on lap, leaving the triple portion of the consolidated engineer's valve operative from the first engine, the same as though the second engine and tender were a car and formed a portion of the train.

While the sequence of operation is similar to other types of brake valves, the time required for release and recharge, with the handle in full release position, has been very materially reduced, owing to design and arrangement of ports and passages. The same is true in the running position, owing to the size and ar-

rangement of ports and the construction of the slide valve feed valve.

The Corrington type of slide valve is interchangeable with, and similar to, existing types in its moving parts and their operation. It has some advantages, however, owing to the arrangement of these parts with reference to each other. By reference to Figure 5 it will be seen that the sensitive or diaphragm portion *A*, is so located, with reference to the nonsensitive or slide valve and piston portion *B*, that the oil and dirt, which to a greater or less extent accumulates in these valves, can only reach the diaphragm portion from the train line ports *E* and *F* and the slide valve bushing, are such as to accommodate in one valve the full volume of air required by the brake cylinders on engine and tender, and the results are equal to those obtained by the two triples as used at present.

The piston, slide valve, and graduating valve, as shown in detail in Figure 3, perform the usual functions, admitting air to the brake cylinders on the engine and tender in the position indicated in Figure 4, and exhausting the brake cylinder pressure to the atmosphere through the cavity in the slide valve the port *A* and the straight air valve when in release or normal position, as shown in Figure 2. The

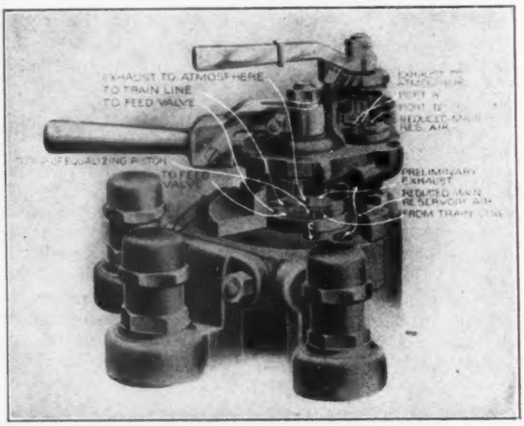


FIG. 4.—SECTION OF AUTOMATIC AND STRAIGHT AIR BRAKE VALVES.

piston chamber, after having first passed through the port *D* leading to the pocket *C* below the piston or non-sensitive portion. This arrangement eliminates the usual difficulty experienced with the small valve operated by the diaphragm, when it is clogged up with dirt or grease. A plug *C* is provided for this pocket so that the accumulation of dirt and grease can be periodically blown out.

The triple valve portion of the consolidated engineer's valve is the same in principle as the plain triples now in use. It is operated by a reduction or increase in train line pressure through the port and passages connecting with the cylinder and train line as shown in Figure 2. The size of the ports in the slide valve, and in the feed groove for recharging is of sufficient capacity to recharge the auxiliary reservoirs for the engine and tender brake cylinders within the proper time, but not sufficiently large to cause a rapid rush of air and a reapplication of the brakes on the engine and tender. For compactness the graduating stem and spring for use in emergency application is included in the triple piston.

The main reservoir, train line, equalizing reservoir and gage connections, as well as all other pipe connections, are made directly to the triple valve body for convenience of cleaning and making repairs making it unnecessary to break any pipe connection for the removal of any portion of the engineer's valve. The di-

mensions from the stud to any of these unions or connections are the same in all respects as the present Westinghouse type of brake valve. Two ¾-inch pipe connections are made to the triple valve, one leading to the auxiliary reservoirs on the engine, and the other to the brake cylinders on engine and tender. The latter contains a special fitting for the automatic high speed valve and a gage connection for the brake cylinder pressures.

The straight air portion of the consolidated engineer's valve constructively forms a part of the cap, enclosing the rotary valve of the brake valve. It consists of a small rotary valve and key which is enclosed or covered by a separate cap held in place by two studs. This cap is provided with an index plate containing notches indicating the release, normal, lap and service positions of the operating handle, the relative location of this handle to the brake valve handle being such as to afford easy and prompt operation of either by the engineer with one hand without interference. The handle of this valve is made square and it is also reduced in size as compared with the brake valve handle so that the engineer can tell by touch which handle is being used.

In Figure 4 the openings constituting port *A*, port *B* and the exhaust to the atmosphere, are shown in the seat of the straight air rotary valve, the port *A* being the termination of the exhaust port from the triple valve, and the port *B*, the termination of a direct connection to the brake cylinders and service port of the triple valve, as indicated in Figure 3 in full section. The additional ports shown in Figure 4, connecting with the cavity in the seat, and not specially indicated, are provided for the purpose of securing additional area of opening and to avoid excessive movement of valve. A fourth, or reduced main reservoir air port is provided, being the termination of the reduced main reservoir air passage leading from the special slide valve feed valve, to which main reservoir pressure is supplied from the cap enclosing the rotary valve of the brake valve and through the port *C*, as indicated.

In the release position of the straight air valve, ports *A* and *B* are both open to the atmosphere. In normal position the port *A* and the exhaust port of the triple are open to the atmosphere. In lap position all ports are closed. In service position the reduced main reservoir pressure is admitted into *B* leading to the brake cylinders. In release position of the handle a warning or alarm port is also opened as a suggestion for returning the valve to normal position. The normal or release position of the handle of the straight air valve corresponds to a running position, and in this position provides a continuous and free outlet to the atmosphere of port *A* from the exhaust cavity of the slide valve and the port of the triple.

Rapid transmission of air to, and exhaust from the brake cylinders, when straight air is used for switching service, has been provided for by increasing the areas of ports *A* and *B*, both of which form a continuous passage from the brake cylinders when the automatic valve is not in use.

The automatic high speed reducing valve used in connection with the engineer's valve is shown in Figure 6. All of the functions are performed by a floating piston *A*, which does not fit the cylinder sufficiently tight to produce a serious friction or require lubrication. Three rows of small holes *D*, of the same size, but varying in number, are provided in the bushing of the cylinder, and these holes govern the escape of air. During the time of highest pressure, the piston *A* is at its limit of travel. The air passes under the piston *A* and through holes *B*, into cavity *C*, and thence through the one row of small holes open at this time, through the holes in the piston, and thence to the atmosphere through openings in cap. In the movement to close, the three rows of holes are opened in succession, the full number being open just before the closing of the valve or piston. The number of holes are increased to suit the capacity of the cylinders on the engine and tender, and in a similar manner, proper outlet is provided to suit various sizes of cylinders on passenger equipment.

The relationship of the straight-air valve portion to the brake valve and triple valve or automatic portion is such that the brakes on the engine and the train can be applied or released in the usual manner. A sudden reduction of train line pressure as a result of train parting, hose bursting, or other similar causes will immediately cause automatic application of the brakes on the engine and cars in the usual way, and without in any way affecting or being

influenced by the straight-air feature of the device. If for any reason, however, it is desired to retain the brakes on the engine and tender, and release on the train for the purpose of recharging, at the same time retaining control of the train, the movement of the straight-air valve handle to lap position, before releasing with the brake valve in the usual way, will close the port *A* to the atmosphere, preventing the escape of air from the brake cylinders on the engine and tender, and allow the triple piston of the consolidated engineer's valve, as well as those on the cars, to move to release position and recharge the auxiliary reservoirs on engine and cars. An increase of pressure in the brake cylinders on the engine and tender can be secured, up to the full limit for which the straight-air feed valve is set, by moving the straight-air valve handle to service position, bringing the port *B*, leading directly to the brake cylinders, as shown in Figure 3, into register, and permitting the reduced main reservoir pressure to flow directly to the brake cylinders. This pressure can be released or partially reduced by movement of the straight-air valve handle to release position.

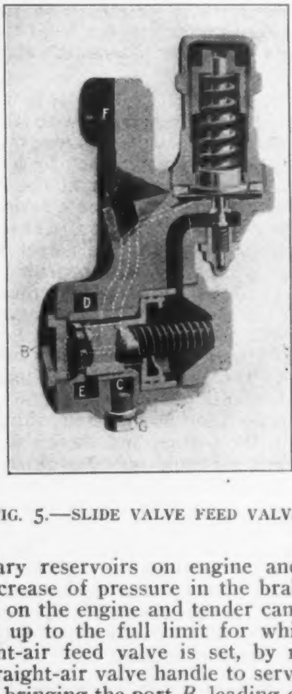


FIG. 5.—SLIDE VALVE FEED VALVE.

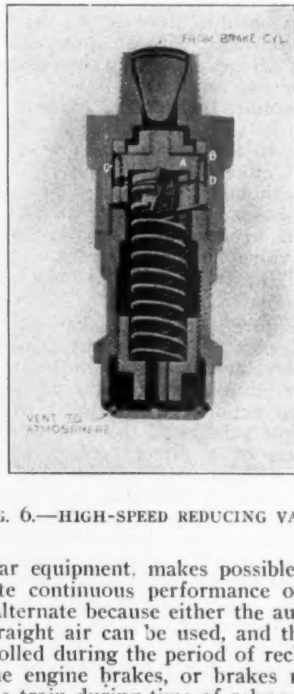


FIG. 6.—HIGH-SPEED REDUCING VALVE.

Having applied the brakes automatically on the engine and tender and throughout the train, they can be released on the engine and tender by moving the straight-air valve handle to full release position. They can be reapplied and the pressure increased or reduced or again released entirely by a repetition of the movement described. Similar movements of the straight-air valve handle make it possible to increase or decrease the pressure in the brake cylinders on the engine and tender during the time the automatic brakes are being applied, and even before the equalizing piston closes.

The combination of the automatic and straight-air systems, when used with present car equipment, makes possible an alternate continuous performance of braking, alternate because either the automatic or straight air can be used, and the train controlled during the period of recharging by the engine brakes, or brakes retained on the train during time of release on engine: and continuous because the engine and train are at no time without brake control. The engineer has entire control of the train at all times.

The brakes on the engine and train can be applied and released in the usual way, using the automatic, or the brakes on the engine and throughout the train can be applied, using the automatic, and with straight-air increase, the brake power on

the engine during the time the brakes are applied on the train can be diminished or released entirely without affecting the brakes on the cars. The brakes throughout the train can be applied in the usual manner, without applying them on the engine and tender, and then applied on the engine and tender to any desired pressure without in any manner affecting the brakes on the cars. They can then be released on the cars without releasing on the engine. The brakes on the engine can be applied with straight air and, without releasing on the engine, applied on the cars in the usual manner, using the automatic. They can then be released on engine and cars in the usual manner, or released on engine alone without affecting the cars. The brakes can be applied on the engine and cars in the usual manner, using the automatic, and released on the train, retaining those on the engine, with any pressure up to the maximum permitted, and during the time the auxiliary reservoirs on cars and on engine are recharging. They can be reapplied on the cars without releasing on the engine, and when applied on the cars the engine brakes can be released without affecting the cars. In double-heading, the engineer on the second engine can release and reapply the brakes on his engine as often as may be desired by means of the straight-air valve, without affecting the brakes on the cars or the first engine. This prevents loose tires. He is also in a position to render assistance in control of train should anything go wrong on first engine. In case the train parts or the train line breaks, the engineer can at once assume as full control of brakes on the engine as though no accident had occurred. By operating the brakes alternately between engine and cars, releasing on one while applying on the other, and vice versa, overheating and loosening engine tires is avoided. The engineer knows exactly, and can vary at will, the pressure holding the engine brakes and can prevent their accidental release or leaking off. Under all circumstances the automatic features are retained on engine and cars, and their full value available in case of accident to the train line.

In the design and construction of the consolidated engineer's valve special attention has been given to wear, accessibility and renewal of parts. All index plates and nuts are case hardened, and the special composition used in valves and seats insures long wear and minimum friction. All surfaces liable to rust or corrosion are brass lined, and special provision has been made for lubrication. All the apparatus furnished is interchangeable.

The Corrington alternate quick-acting brake system includes, in addition to the consolidated engineer's valve, all that constitutes the complete engine and car equipment required by railroads. It is interchangeable with existing standards, with two exceptions, namely, the automatic high-speed reducing valve and the method of venting the train line to the atmosphere in emergency applications. The automatic high-speed reducing valve, Figure 10, is identical in action with the Westinghouse type, though different in construction. It is of small size and screws directly into the brake cylinder. The method of venting train line air to atmosphere in emergency consists of a piston and check valve inserted in check valve case in place of the usual check valve, a bushing in the bottom of the check valve case opening to the atmosphere, and forming a seat for the small check valve, which is connected to and actuated by the piston. All other portions of the triple valve are identical with the Westinghouse type.—*Railroad Gazette.*

Compressed Air in Electric Railway Work—The Air Brake—II.

It is in its application to braking for the modern electric railway car that compressed air finds its most general use in connection with electric railway work, and perhaps this may be called its most useful application, for without the air brake the passing from speeds of 10 and 15 miles an hour to 25, 30, 40 and even 50 and 60 miles an hour to which we are rapidly becoming accustomed, would hardly have been possible. It is proper therefore in an article upon the uses of compressed air to devote considerable space to the air brake.

At the present time there are two well known and widely used classes of compressed air brakes for electric railway service: those commonly known as the "Christensen" systems, developed and controlled by the National Electric Co., successor to the Christensen Engineering

Co.; and those made under "Westinghouse" patents by the Westinghouse Traction Brake Co. There are other systems in use, several of which possess advantageous features, but the two companies mentioned control the bulk of the business, and their various styles of equipments may be said to represent the standard accepted types.

Both of these companies have very recently brought forward new equipments for electric service, improved as to details, and the descriptions appended have been furnished expressly for this article by the engineers of the respective companies. The data on the power required for compressing air for braking purposes especially will be found new and interesting.

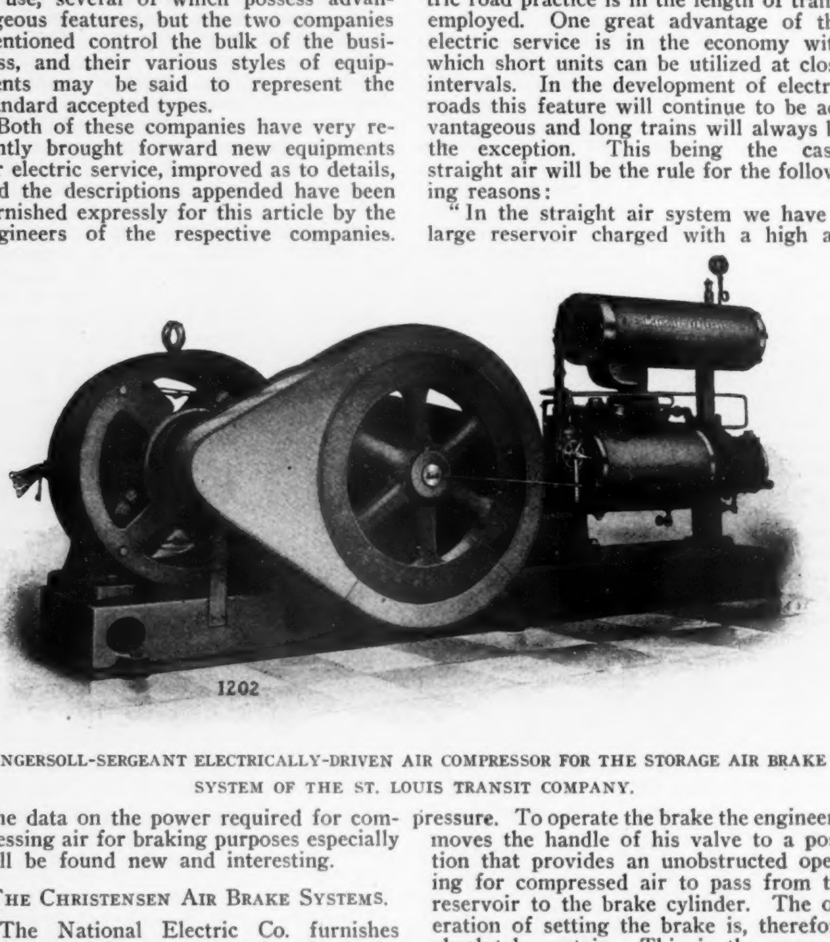
THE CHRISTENSEN AIR BRAKE SYSTEMS.

The National Electric Co. furnishes either straight or automatic air brake equipments, but its recommendations are strongly in favor of straight air for ordinary electric railway service. In this connection we quote the following remarks on the advantages of straight air over automatic:

"On account of the remarkable success attained in the use of automatic air for braking cars in steam road practice, an impression seems to exist in some minds that automatic air is preferable to straight in any service. This is an error which will become apparent upon second thought. A marked difference between steam and electric road practice is in the length of trains employed. One great advantage of the electric service is in the economy with which short units can be utilized at close intervals. In the development of electric roads this feature will continue to be advantageous and long trains will always be the exception. This being the case, straight air will be the rule for the following reasons:

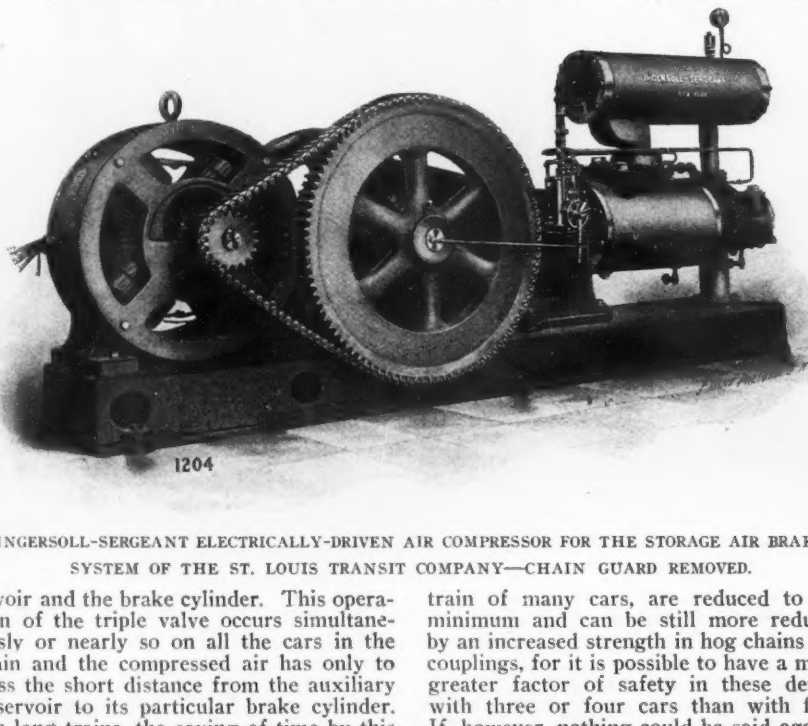
"In the straight air system we have a large reservoir charged with a high air pressure. To operate the brake the engineer moves the handle of his valve to a position that provides an unobstructed opening for compressed air to pass from the reservoir to the brake cylinder. The operation of setting the brake is, therefore, absolutely certain. This is the acme of simplicity which carries with it absolute certainty. The time elapsing before the pressure is equalized between the reservoir and the brake cylinder on the last car of a train of three or four cars through a ½-inch or ¾-inch pipe is so short as to be practically instantaneous, consequently the brake is set as quickly on all the cars in the train as is possible by any system.

"In the automatic air system we have an auxiliary reservoir in close proximity



INGERSOLL-SERGEANT ELECTRICALLY-DRIVEN AIR COMPRESSOR FOR THE STORAGE AIR BRAKE SYSTEM OF THE ST. LOUIS TRANSIT COMPANY.

to the brake cylinder on each car, and between the brake cylinder and the auxiliary reservoir is placed the triple valve. All the triple valves on the train are connected to each other and to the engineer's valve on the motor car by the train line. The triple valve is operated by reducing the pressure in the train line, which is accomplished by moving the handle of the engineer's valve to open a port communication from the train line to the atmosphere. When the pressure in the train line is reduced six or eight pounds, the triple valve automatically operates, creating an opening between the auxiliary reservoir and the brake cylinder. This operation of the triple valve occurs simultaneously or nearly so on all the cars in the train and the compressed air has only to pass the short distance from the auxiliary reservoir to its particular brake cylinder. On long trains, the saving of time by this method results in setting the brakes on the last car quicker than would be the case with the straight air system. In the short train, however, the time consumed in reducing the pressure in the train pipe, and the operating of the triple valves, is fully as much as that required in the straight air system in delivering air from the main reservoir on the motor car to the brake cylinder on the last car in the train.



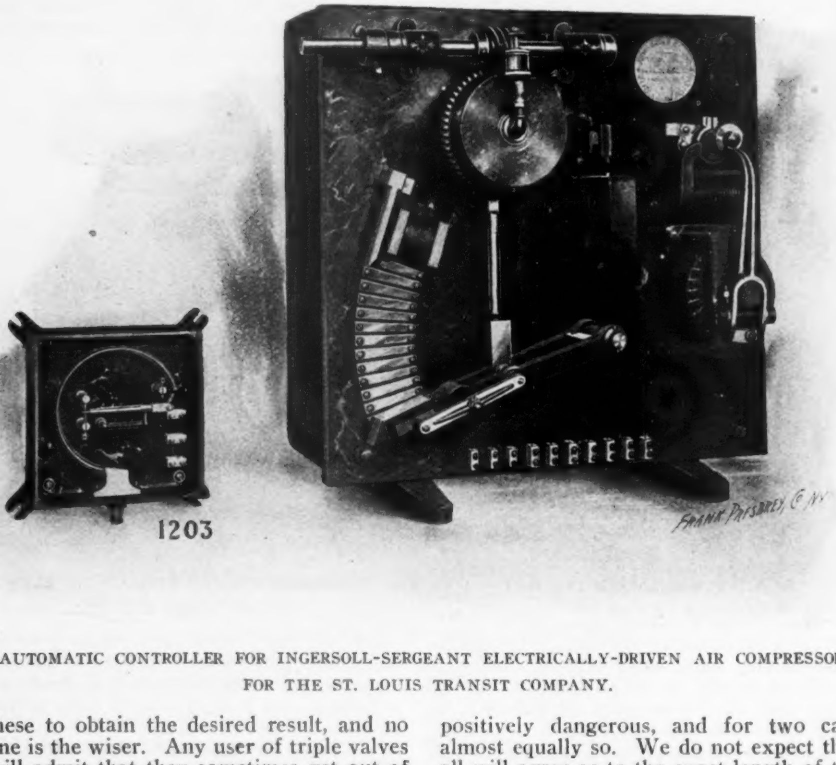
INGERSOLL-SERGEANT ELECTRICALLY-DRIVEN AIR COMPRESSOR FOR THE STORAGE AIR BRAKE SYSTEM OF THE ST. LOUIS TRANSIT COMPANY—CHAIN GUARD REMOVED.

Thus it cannot be claimed that the brakes in a short train can be set any quicker with the automatic than with the straight air system and on single or two-car trains the advantage, though too slight to be of much importance, is with the straight air system.

"Should a train of cars equipped with automatic air break in two, the train pipe would also be broken and a reduction of air in the same would take place, which would cause the triple valve to operate and both sections of the train would be stopped, but the chances of a short train breaking in two, as compared with a heavy train of many cars, are reduced to the minimum and can be still more reduced by an increased strength in hog chains and couplings, for it is possible to have a much greater factor of safety in these details with three or four cars than with fifty. If, however, nothing could be said against the automatic system for short trains, the above advantage would be worthy of consideration, but to counter-balance this advantage we submit the following: The engineer's automatic valve is complicated, compared with the straight air valve, and, therefore, in direct proportion to its complication, more liable to fail. Further, the triple valve as compared with an unobstructed opening between the reservoir and

brake cylinder is also complicated. If we have a train of, say fifteen cars, equipped with automatic air, and one, two, even three triple valves fail to operate, a stop will be made within the usual distance, for the engineer gauges the amount of reduction of his train pipe pressure, which controls the amount of pressure in the brake cylinder, by the effect which he feels is exerted in stopping the train, and, if only twelve brake cylinders are in operation, he will increase the amount of pressure on these to obtain the desired result, and no one is the wiser. Any user of triple valves will admit that they sometimes get out of order and do not operate. Should this occur on a single car, the motorman would be helpless to stop the car. On a train of two cars, should the triple valve on the motor car fail to operate, the train must depend on the traction of the light trailer car for stoppage, and as the light trail car probably exerts less than one-third the traction of the train, the stop would be very slow and long drawn out.

"The question thus resolves itself into the selection of the lesser of two evils, and our conclusion must be determined by our opinion as to whether failure of any one triple valve is more likely to occur than the parting of a short, light train equipped with heavy couplings and hog chains and should be further influenced by whether the results in one case are more likely to be disastrous than in the other. For our own part we consider the equipment of single cars with automatic air not only folly, but positively dangerous, and for two cars almost equally so. We do not expect that all will agree as to the exact length of the train on which it becomes an advantage to place automatic air devices, but in our opinion there is no question that for trains of three cars or less straight air is the safest, cheapest and most easily maintained in perfect order.



AUTOMATIC CONTROLLER FOR INGERSOLL-SERGEANT ELECTRICALLY-DRIVEN AIR COMPRESSOR FOR THE ST. LOUIS TRANSIT COMPANY.

"Another advantage possessed by the straight air system is in the fact that the operator can diminish or increase the amount of pressure in the brake cylinder

at will and with a very nice degree of accuracy, whereas with the automatic system, in order to diminish the pressure it is necessary to release the brakes entirely and reset to the desired extent. This function of the straight air system is very convenient in drifting down long hills with varying grades as well as in making stops when such stops have to be made accurately at a given point.

"Figure 1 shows a diagrammatic arrangement of the straight air brake system for a motor car and one or more trailers, and Figure 2 shows the automatic air brake arrangement for a motor car and one or more trailers.

"These plates are arranged alongside of each other for the purpose of distinctly showing the relative simplicity of straight air brakes compared with automatic."

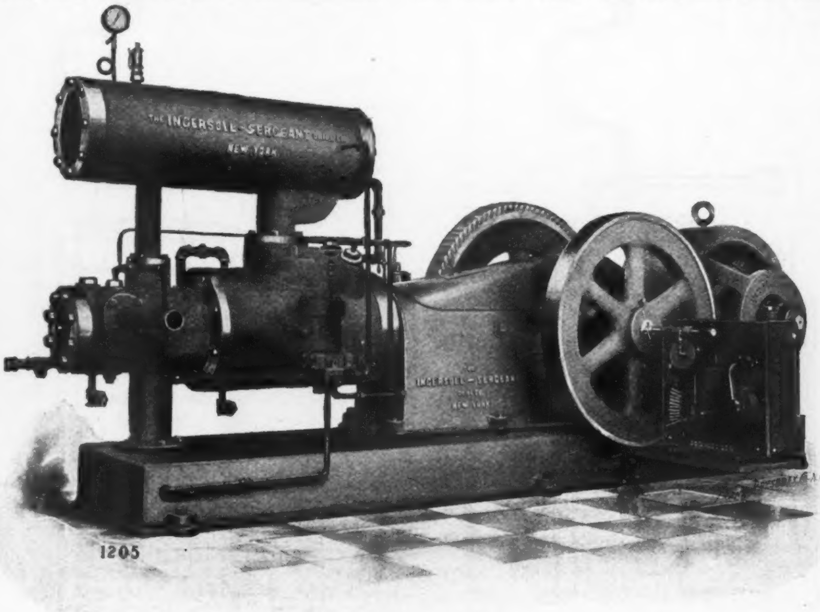
The Christensen straight air brake equipment has been described fully in the columns of the *Review* (see the *Review* for April, 1902). So recapitulate briefly, it consists of the following essential parts:

1. The air compressor, which furnishes the compressed air. This consists of a series wound motor and duplex single acting compressor having two pistons, the two machines combined into a single compact piece of apparatus, the motor driving the crank shaft of the compressor through gear and pinion. All moving parts run in oil and are completely inclosed and protected from dirt and moisture.

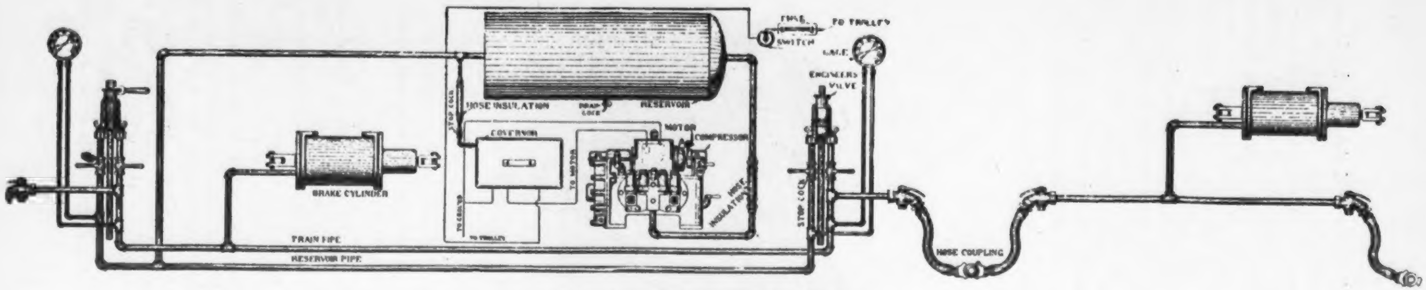
2. The automatic governor, which stops and starts the air compressor by the variation of pressure in the main reservoir.

3. The air gauge, which is provided with two hands, one indicating the pressure in the main reservoir, and the other the pressure in the train pipe, the former hand being painted red and the latter black. A plain single hand gauge may be used in place of a duplex to show the pressure in the main reservoir only; the duplex being more particularly adapted for automatic air brake equipments.

4. The pipe connecting the main reservoir with the engineer's brake valve, and the pipe leading from this valve and extending throughout the whole length of the train. The latter is known as the train pipe and is provided with hose couplings

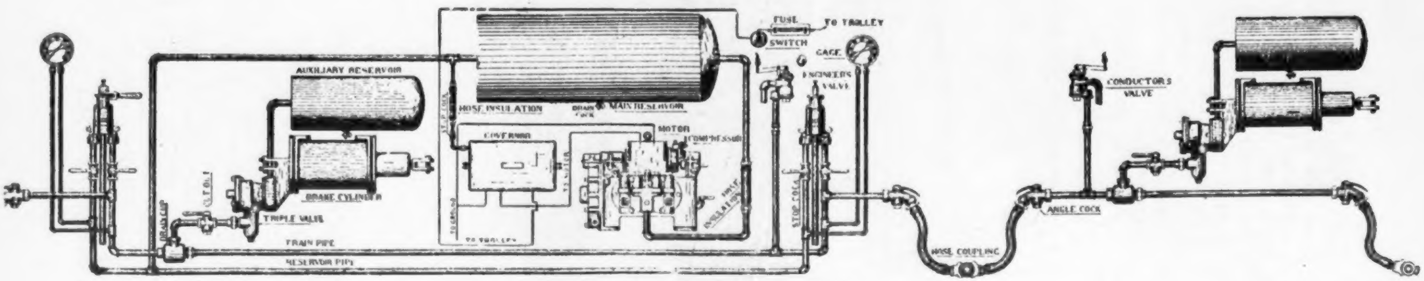


INGERSOLL-SERGEANT ELECTRICALLY-DRIVEN AIR COMPRESSOR FOR THE STORAGE AIR BRAKE SYSTEM OF THE ST. LOUIS TRANSIT COMPANY.



Courtesy of *Street Railway Review.*

FIG. I.—DIAGRAM OF CHRISTENSEN STRAIGHT AIR EQUIPMENT.



Courtesy of *Street Railway Review.*

FIG 2.—DIAGRAM OF CHRISTENSEN AUTOMATIC AIR EQUIPMENT.

between the individual cars, with stop cocks at each end of each car and with a branch pipe connected to the brake cylinder, arranged under each car.

5. The main reservoir in which the compressed air is stored.

6. The engineer's brake valve, by which air is admitted from the main reservoir to the brake cylinder and from the brake cylinder to the atmosphere.

7. The brake cylinder, provided with a piston having its rod attached to the brake lever system in such a manner that when compressed air is introduced into the brake cylinder by means of the engineer's brake valve, the brake shoes are forced against the wheels by the compressed air acting on the area of the brake cylinder piston.

8. The hose couplings arranged on each end of each car, by which the train pipes on the cars are connected, thereby forming a continuous train pipe line.

Power Required for Operating Air Brake.

Mr. W. J. Richards, of the National Electric Co., supplies the following data:

"The motors are series wound, and are started and stopped at predetermined pressures by means of an automatic governor. No starting rheostat is used, the voltage being impressed directly upon the motor. The starting current is from one and one-half to two times normal full load current, and varies but slightly with change of reservoir pressure against which the compressor is started.

"The motors are designed for intermittent running, and are given the same kind of factory test as is given street car motors. The temperature rise permitted, however, is less than that allowed in street car motors. The following gives the average temperature rise above the surrounding air of the several parts of the motor-compressor for one hour run: Field coils, 55 degrees C.; armature, 40 degrees C.; yoke, 25 degrees C.; compressor cylinder, 50 degrees C. The operation of the motor from a standpoint of sparkling is better than that of street car motors. That this is so is partly due to the fact that the armature is run in but one direction, thereby permitting the setting of the brushes in a position favorable to good commutation. All commutators should polish when working under normal load.

"The construction of these motors must be most rigid and painstaking, inasmuch as they must operate in a position difficult of access where but little care can be given them. They must also be constructed to operate on a grounded circuit, and for this reason are constructed to stand a test of 2,000 volts, a. c., to ground immediately after a temperature of one hour.

"For ordinary single car equipments a compressor of 11 cubic feet of free air per minute when running at full load on the motor is required. This requires a motor to operate the compressor with an input capacity of about 3.7 amperes at 550 volts, when pumping against 90 lbs. The actual time to fill a 4-cubic foot reservoir to 90 pounds pressure is about 2 minutes and 15 seconds. In this connection it must be remembered that at the lower pressures the actual capacity of the pump is greater than 11 cubic feet of free air per minute, inasmuch as the motor runs at a much higher speed at part load than at full load. The average time for pumping from 80 pounds to 90 pounds into a 4-cubic foot reservoir, is about 25 seconds.

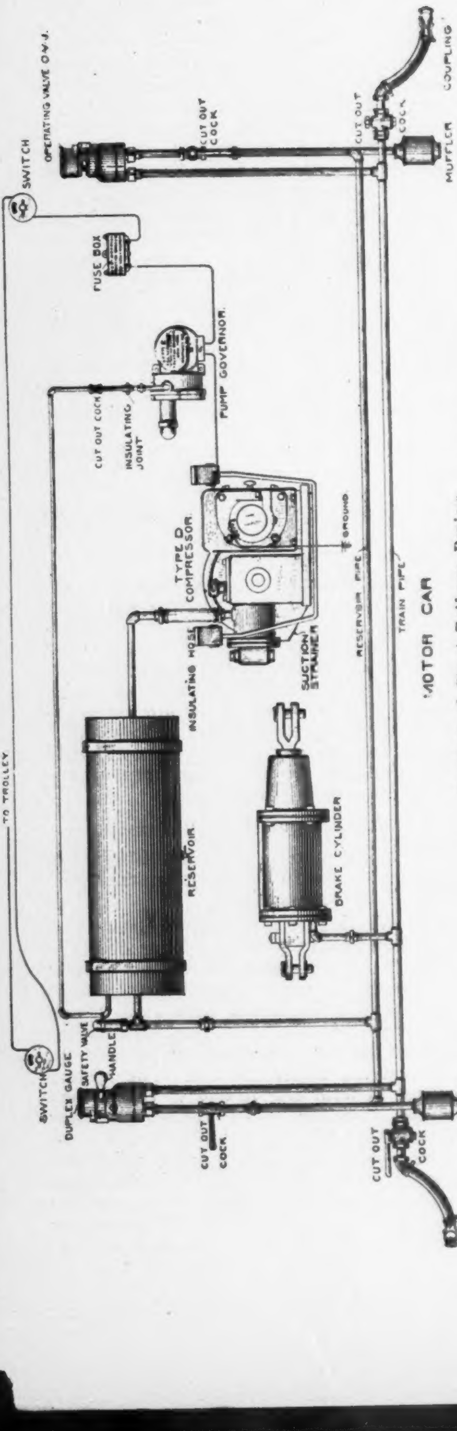
"For large cars, such as are used on elevated trains, where a motor compressor is furnished with each car, a motor compressor of 20 cubic feet of free air per minute is ordinarily used, requiring about a 4 horse-power motor. Where an entire train is supplied from one motor compressor, motor compressors from 35 to 50 cubic feet of free air per minute are ordinarily used, requiring from 7 to 10 horse-power motors to operate them."

Westinghouse Air Brakes.

The Westinghouse Traction Brake Co. furnishes us the following statement of its work in this connection:

The Westinghouse Traction Brake Co., which handles the product of the air brake company of the same name for electric railway service, offers a number of systems of air brakes, including both axle driven and motor driven compressors and brakes operated by air stored under pressure in tanks carried under the car. The system in most general use to-day is that which includes a motor driven compressor unit on every car.

The source of the air for operating the brakes in this system is the Westinghouse duplex motor compressor. This machine is dust and water proof, obviating the necessity of enclosing it in a box and re-



Courtesy of *Street Railway Review.*

FIG. 3.—DIAGRAM OF WESTINGHOUSE STRAIGHT AIR EQUIPMENT.

moving the possibility of dust and dirt getting in to cause excessive wear of the bearings and impair the efficiency of the machine. Enclosing a compressor of the type required for braking systems tends greatly to impair its efficiency through the lack of proper ventilation. The motor of this machine drives the compressor portion by means of a tempered steel chain, which does away with the noise of gearing. Another advantage of this chain drive is found in the ease with which the lost motion, resulting from wear, can be taken up, the motor frame being so arranged that slack in the chain can be provided for by adjusting the distance between the pinion and sprocket. Automatic lubrication is provided by a system of oil circulation. The chain and cranks run in baths of oil and the bearings are lubricated automatically. The pump and armature shafts, however, are so arranged that no oil can escape from them into the motor case, thus protecting the winding of the motor.

The pump motor is automatically started or stopped, when the predetermined maximum or minimum air pressure has been reached, by a pump governor. This, like the compressor, is dust and water proof. The mechanism of this device is actuated by the pressure of the air against a substantial piston. When the pressure reaches the predetermined maximum, this piston throws a double break switch provided with magnetic blow-out. The reduction of pressure below the predetermined minimum point causes a reverse action and again closes the pump circuit.

For cars which operate singly or haul one or more trailers, the brake system used is generally that known as the " Straight Air System." In this type of apparatus the air from the compressor, which is stored in a reservoir, is piped to an operating valve and thence to the brake cylinder. In applying the brakes the operating valve is moved so as to admit air from the reservoir to the brake cylinder and in releasing the same the port from the main reservoir is closed and the air from the brake cylinder allowed to exhaust to the atmosphere.

The Westinghouse operating valve is a plain sliding valve so designed that it wears itself into place, continually finding its own seat without repairs or attention. The Westinghouse Company has the gage mounted directly on the valve stand, forming a part of the operating valve. This

gage shows pressure in the reservoir and also that in the cylinder. Its face is protected by heavy plate glass. Its position brings it immediately under the eye of the operator. The operating handle that is used with this valve can only be inserted or removed when the valve is in lap position and all ports are closed. When this handle is removed the operating mechanism is fully protected from meddling by passengers.

The exhaust from straight air brakes is conducted to the atmosphere through a muffler to avoid the disagreeable noise caused by the direct rush of air under pressure to the atmosphere. This apparatus is also provided with a safety valve connected in the piping near the main reservoir, as a measure of protection in case for any reason the compressor should continue to operate for any length of time after the predetermined maximum pressure has been reached. This company provides its reservoirs with drain cocks so that water can easily be drained from them. Water in reservoirs causes trouble, not not only by reducing the volume, but also by running over into the valves and freezing in cold weather. Consequently it is of the greatest importance that the reservoirs be drained at least once a week.

The automatic system of air brakes finds its sphere where the cars are operated in trains. Its two great advantages are safety and smoothness of application, and in case of accident to train pipe or couplings or in a break-in-two, with the automatic system, the brakes are set instantly on every car in the train. Furthermore, with the automatic air the disadvantage of successive brake applications on the cars in the train, resulting in disagreeable bumping, is avoided, as the brakes are set on every car almost at the same instant.

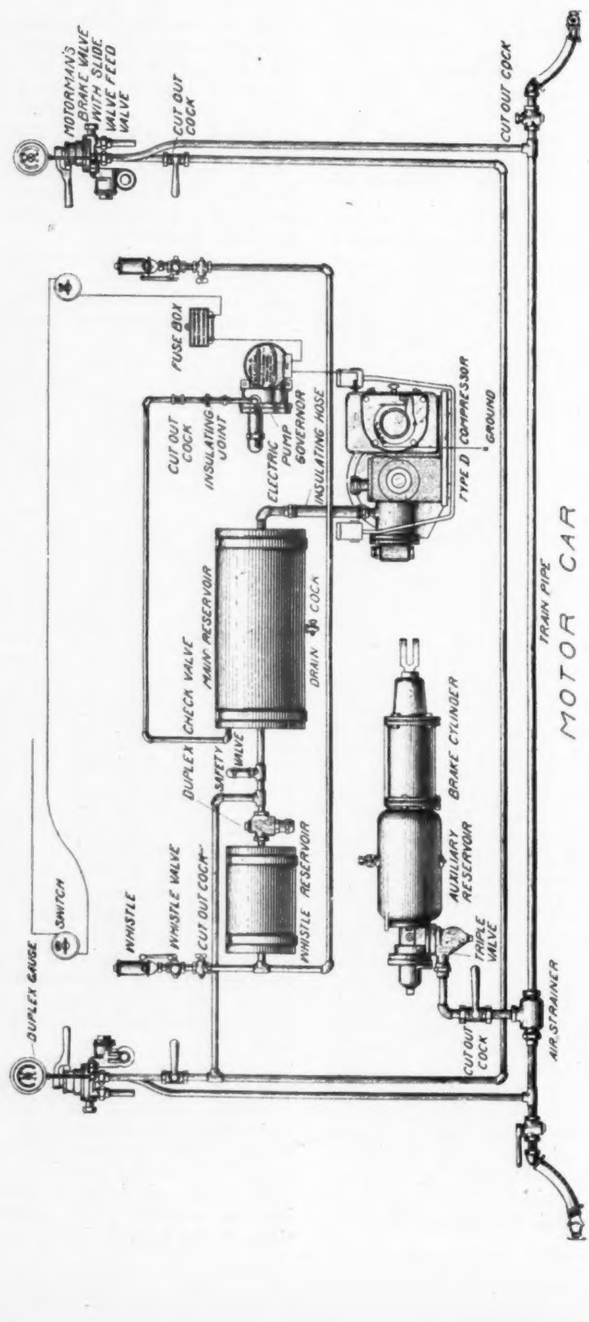
With the exception of the electric driven compressor the automatic air brakes which this company furnishes are identical with those that have proved so successful in steam railway service. The Westinghouse triple valve in emergency applications vents from the train pipe to the brake cylinder, insuring 20 per cent. higher pressure than can be obtained with plain triple valves or those which vent the train pipe to the atmosphere. This triple valve is capable of following a service application by an emergency application without first making a complete release and recharging the train pipe.

The type of brake cylinder depends on the room under the car. This may be either the regular Westinghouse passenger type with detached auxiliary reservoir or, what is just as well adapted to traction service, a combined auxiliary reservoir and brake cylinder. With this, however, is furnished a standard passenger triple valve.

The automatic equipments, like the straight air brakes, also include drain cocks for all reservoirs, and safety valve for main reservoir.

The operating valve used with this type of brake when trains of not over six or eight cars are handled differs from that used in steam railway practice in that it does not contain the equalizing discharge valve. This feature is only necessary where long trains are handled, as in steam railway service, and it is only occasionally that service conditions on electric roads require the use of the regular engineer's valve. This valve has three pipes leading to it. One of these is from the main reservoir. one goes to the train line, which, indirectly through the triple, leads to the brake cylinder; and one goes to the exhaust. The handle which operates the valve has five positions, viz.: release, running position, lap, service and emergency. The running position is that occupied when the cars are in motion and the brakes are not applied or in operation in any way. In this position the train line is connected to the main reservoir through the slide valve feed valve, which forms a portion of the motorman's brake valve. The feed valve thus supplies all leaks in the train line. The air in the main reservoir is maintained at a pressure of 90 pounds; that in the train line is kept at 70 pounds. The slide valve feed valve reduces the 90-pound air to 70-pound air. In the release position 90 pounds of air in the main reservoir is connected to the train line, which has been reduced below its initial 70 pounds by the application of the brakes, and is now brought up to 70 pounds by this excess of pressure in the main reservoir.

The triple valve has four openings or pipes to it: One to the brake cylinder; one to the auxiliary reservoir; one to the train line and one to the atmosphere. To apply the brakes move the motorman's brake valve handle to service position. This exhaust some of the air from the train line, bringing the pressure there below 70 pounds; then the 70 pounds in the auxiliary reser-



Courtesy of *Street Railway Review.*

FIG. 4.—DIAGRAM OF WESTINGHOUSE AUTOMATIC AIR EQUIPMENT.

voir acts on the piston of the triple valve and moves it forward, thus opening communication between auxiliary reservoir and the brake cylinder, and allowing the air from the auxiliary to move the piston of the brake cylinder and apply the brakes. Since this train line is connected from car to car and the triple valve on each car is connected to the train line, the reduction of pressure in the train line causes every triple valve to act at practically the same time. To release the brakes the handle of the brake valve is turned to release position, which recharges the auxiliary reservoirs and lets the air from the brake cylinder exhaust to the atmosphere. The conductor's valve on each car is connected to the train line. When opened it reduces train line pressure and sets the brakes just as the motorman's brake valve does.

The main reservoirs are connected from car to car by an additional train line in order to give the advantage of the large volume for recharging and also that the governors may each cut in its pump when the pressure is reduced to the cutting in pressure.

Although automatic air can be used when cars are operated singly, still straight air is generally considered the most advantageous for this kind of service, due, as stated before, to the directness, certainty and simplicity of the straight air application. The air which actuates the brake cylinder piston is admitted directly through the medium of an operating valve without the interposition of the complicated triple valve, and the braking force is thus under much closer control of the motorman, the advantages of the triple valve lying in its avoidance of the successive application of brakes on the cars in the train, and also in the automatic application of the brakes in case of accident With straight air the motorman can diminish or increase the amount of pressure in the brake cylinder at will; while with the automatic system, in order to diminish the pressure, the brakes must be entirely released and then reset. The release with the straight air system is also very much quicker than with automatic air. Service conditions on a great many roads require the operation of cars singly for a portion of the day and in trains during the rush hours. Furthermore, electric motor cars on a great many roads are used at times to haul trains of steam railway freight cars or passenger coaches or of electric railway trailers. For service conditions of this kind the Westinghouse Company offers ar equipment by the use of which either straight or automatic air is made available on the same car. This secures additional advantages from the fact that the presence of the straight air on the motor car makes it possible to hold a train when standing on grades, at the same time recharging the automatic system, to have the train brakes ready for immediate use on starting. This system requires the use of a straight air operating valve, as well as a motorman's brake valve.

Automatic separation of the two portions of this apparatus is effected by a double check valve, which has four openings; one leading to the straight air side and straight air operating valve; one tc the safety valve; one to the automatic side or triple valve, and one to the brake cylinder. The air is carried from the main reservoir by two separate lines to the separate operating valves and from them to the double check valve from the straight air side, and through the triple to the double check valve on the automatic side. When using automatic brakes the air goes into the check valve from the triple, pushing back a piston which closes the port leading to the straight air operating valve, and opening the port to the brake cylinder. When the straight air system is used the air comes in direct from the operating valve, and by pushing the piston in the opposite direction, closes the port leading to the triple valve and enters the brake cylinder. This system has been largely used on switching locomotives in steam railway service, where it has proved eminently satisfactory, and it bids fair to find an extensive use in the electric railway field.

Storage Air Brakes.

The storage system of air brakes may be regarded as still in a more or less experimental stage, as its use is very slight as compared with the motor compressor system. The first large installation of storage air brakes is at St. Louis, where the Westinghouse Company is at present installing 1,500 equipments on the cars of the St. Louis Transit Co.

In this system the air for operating the brakes is stored in steel tanks under the car at a pressure of 300 pounds. From these tanks it is conducted to a service reservoir corresponding to the main reservoir of the motor compressor equipment. In the pipe line between the storage

reservoir and service reservoir is placed a reducing valve, which is set to bring the 300-pound air down to 65 pounds. This system requires the erection of stationary air compressing plants, provided with air compressors and storage tanks. These air compressing plants, including 40 electrically driven air compressors, were furnished by the Ingersoll-Sergeant Drill Co.

In operation the cars must be stopped at these stations and charged from an air hydrant which is connected with the storage reservoir through a hose and coupling. The matter of charging varies greatly with running conditions, and it is hard to set any standard. In the storage system now installed the total time required in charging the cars, including allowance for stopping and for getting under way, is from 30 seconds up, depending on the skill of employees in charge.

The operation of the car brake equipment is substantially similar to that of the motor compressor system. The equipment includes drain cocks and safety valves, and also an additional gage to indicate the pressure in the storage tanks.

The sphere of the storage system of air brakes is yet to be determined. There are suburban lines and city lines operating under this system, but it is probable that it will find its widest application in city service, where the headways are small and the arrangement of routes is such as to make this system of brakes available.

One of the greatest faults in street railway practice to-day is the lack of care which is given to brake equipments. The reservoirs should be drained at least once a week. The shoe slack should be well taken up so that the piston never travels more than 8 inches when full pressure is applied. Brake levers and pins should be regularly inspected. The piping should be kept tight and the motorman instructed in the economical use of air. This will save excessive operation of the compressor. Compressors of a type required for braking systems should never be required to work more than half of each hour and under proper conditions should never operate more than one-third of the time in the city service. Thorough care and inspection of the brake apparatus will prove a true economy with electric roads, as it has been with steam roads, and it is probable with the further development of electric railways that they will more nearly approach the steam railway standards in these matters.

Air Whistles.

Air whistles have now come into general use on electric cars equipped with air brakes. The whistle can be heard at a much longer distance than an ordinary gong, and can be mounted to occupy less space. Both of the prominent brake companies supply air whistles with all equipments, and either company will furnish whistles either to take air from the main brake reservoir or from an auxiliary reservoir. The Westinghouse Company recommends the use of an additional reservoir with a check valve placed in the pipe line between it and the main reservoir. With the straight air system the advantage of this is found in the additional amount of air it makes available to supply the demands of the whistle. When this arrangement is used, excessive use of the whistle cannot prevent the proper application of the brakes in emergency by reducing the available pressure.

With the automatic system, in addition to giving an increased volume of available air, the use of the whistle reservoir is important to prevent setting the brakes through the excessive use of the whistle, which could be done by so reducing the pressure in the main reservoir that the pressure in the train line would be reduced below 70 pounds. However, with automatic air brakes the use of separate reservoir with check valve is variously regarded. A few railway companies who employ only high-class motormen state that they prefer to trust the use of the whistle to their motormen's judgment. They say that in the event of running into any one at a crossing they would be less liable to be held for damages if it could be shown that the whistle had been regularly used, and in the event of their having a small whistle reservoir in which pressure had been so reduced by whistling, previous to an accident, that there was no air available to operate the whistle, pressure in the main reservoir not having been sufficiently high at the time to recharge the whistle reservoir, it would go much harder with the company in the trial than would have been the case if the apparatus had been so arranged that the whistle would have had available the main reservoir supply of air. The use of this reservoir with automatic equipments is therefore largely influenced by local operating conditions.

The whistle is preferably placed above the motorman's cab and connected by

½-inch pipe to the whistle valve. This valve should be placed inside the cab and as close to the whistle as possible. The whistle valve should be connected to the main reservoir pipe and never to the governor line under any conditions. A cord may be run from one end of the whistle lever across the cab, with enough slack to come within easy reach of the mortorman. On open cars the whistle may be placed below the platform and operated by means of a wire attached to the lever handle and brought up through the floor. It is not recommended that this valve be arranged to be operated with the foot, as this practice usually leads to the disadvantageous waste of air.—*Street Railway Review.*

The Production of Cold by the Utilization of the Exhaust from Motors Driven by Compressed Air.*

The application of the cold air escaping from a compressed air motor for the production of cold has already been suggested by M. Giffard. The installation now described in the restaurant of Messrs. Karcher, Paris, was planned and carried out in the firm's own shops by Mr. George Kolb, their engineer.

THE MOTOR.—The engine driving the dynamo for lighting is an old Frikart steam-engine, with a piston 17 inches diameter and 36-inch stroke. It was chosen on account of the exhaust pipe being 7 inches diameter, for there is the danger that, when from some cause or other the air is moist, white frost may accumulate and obstruct a narrow passage. The motor is supplied with its compressed air from the establishment of Messrs. Popp at a pressure of 11⅕ pounds, and at an average temperature of from 59 degrees to 66 degrees Fahr.—never higher than 77 degrees in summer. It works from ten to twelve hours in the winter and seven or eight hours per day in the summer. It is lubricated with glycerine, for the mineral oils communicated a disagreeable smell to the exhaust, which might have affected the quality of the ice made. The engine develops about 30 horse-power during the week and from 40 to 45 horse-power on Sundays, and can be worked up to 60 horse-power. It drives a dynamo of 300 ampères and 110 to 115 volts for lighting purposes.

* A report by Mr. Walter Meunier to the Industrial Society of Mulhouse as published in "Ice and Cold Storage."

THE REFRIGERATION INSTALLATION.—The theoretical difference in temperature between the air admitted and the exhaust is 190 degrees Fahr. In reality the temperature at the exhaust reaches — 135 degrees Fahr. It often happens in winter, after thirteen or fourteen hours' working, that the alcohol thermometer marked down to — 102 degrees Fahr. cannot be read at all. The compressed air exhaust is first used for producing ice, then for cooling the beer stores in the basement, in which the temperature has to be kept below 46 degrees Fahr. A trial was also made of using the cold for cooling the customers' accommodation, but this installation had to be abandoned. The customers complained of cold feet, and they were likewise annoyed by the noise of the exhaust, which took place under a little more than atmospheric pressure.

The machine is in the basement, where there is a cold chamber serving as a reserve for the surplus of the ice produced beyond that required for immediate consumption; also the beer cellar and the dynamo room.

The walls, ceilings and floors of the two first rooms, as also the wall of the cellar next the open air, are made of cork compo, and covered with wood panelling. The walls of the cold room and of the cellar, which are a portion of the wall of the building, are covered with the latter only. The kitchen, situated over the cold room and the ice-house, is isolated from the ceilings of the two latter by a stratum of air and a flooring laid on ⊥ iron. The cold room and ice-house are 10 feet long, 15 feet broad and 5 feet 9 inches high. The cellar is arranged to hold 22,009 gallons of beer in casks ranged on stillions placed on the ground.

The exhaust duct is 7 inches diameter on leaving the engine, gradually increasing to 16 inches diameter where it enters the cold room a little above the floor. The ice is made in this room. The water to be frozen is run into flat basins widening above, and containing 24½ pounds each. They are ranged on galvanized iron staging to facilitate their handling. The party wall between the cold chamber and the ice room is removable, so that the ice can be easily stored.

The air for cooling the cellar is taken from the top of the cold chamber by a

16-inch duct, which runs some distance into the cellar. In the passage separating the cold chamber from the cellar there is an outlet duct connected to a chimney which communicates with the open air through the roof. There are valves to regulate the supply of cold air to and exhaust from the cellar. By means of these two valves the cellar can be kept at a constant temperature of 46 degrees Fahr., whatever be the speed of the motor or the temperature of the outside air, or of that in the cellar. While the machinery is at rest, the beer in the cellar is kept cool with ice taken from the ice-house, when necessary.

Thus the utilization of the exhaust of the compressed air motor, which serves for the lighting, furnishes also all the ice and refrigeration required for running the establishment.

COST.—The cubic meter (1.31 cubic yards) of compressed air comes out at 0.008 franc; the consumption per hour per horse-power is 24 cubic meters, and the cost price per kilowatt hour under these conditions is 0.32 franc. On the other hand, the ice, if it were purchased, would cost 5 francs (4s.) per 100 kilograms (213 pounds). To cool the cellar, 5 kilograms per hectolitre (22 gallons) are required, the 500 kilograms required for the 100 hectolitres of beer contained in the cellar during seven hours' working in summer working out at 71.43 kilograms of ice per hour. The production of ice per horse-power per hour being 4 kilograms, works out at 6.40 kilograms per kilowatt. It is difficult to fix the working expenses with absolute exactness, and the tests were limited to three runs for lighting, the average maximum output being 300 ampères and 110 volts, and the minimum 120 ampères and 110 volts. The figures below were submitted to Mr. Kolb, who agreed with them. The profit resulting from the use of the exhaust, compared with the cost of buying the ice, comes out as follows:

(1.) Working at 58.80 horse-power—300 ampères, 115 volts = 34.5 kilowatts.

Production of ice per hour, 34.5 × 6.4 = 220.80 kilos., at cost price, 5 francs the 100 kilos.	11.04	fr.
Cooling the cellar, 71.43 kilos., at 5 francs per 100 kilos.	3.57	"
Cost of ice without the refrigerating installation, per hour	14.61	fr.
Cost of driving power, 34.5 kilowatts, at 0.32 francs.	11.04	"
Profit per hour	3.56	fr.

—representing the exact expense incurred to cool the cellar if ice had to be bought. There is, besides, a further gain of 220.80 kilos. of ice produced.

(2.) Working at 52.80 horse-power, — 300 ampères, 110 volts = 33 kilowatts.

Ice produced per hour, 33 × 6.4 = 211.20 kilos., purchase price 5 francs per 100 kilos.	10.56	fr.
Cooling the cellar, as above	3.57	"
Expenses for ice without the refrigeration installation	14.13	fr.
Expenses for motive power, 33 × 0.32	10.56	"
Profit per hour	3.57	fr.

—cost of cooling the cellar, presuming the ice had to be bought, plus the 211.20 kilos. of ice produced.

(3.) Working machine at 21.12 horse-power, — 120 ampères, 110 volts = 13.20 kilowatts.

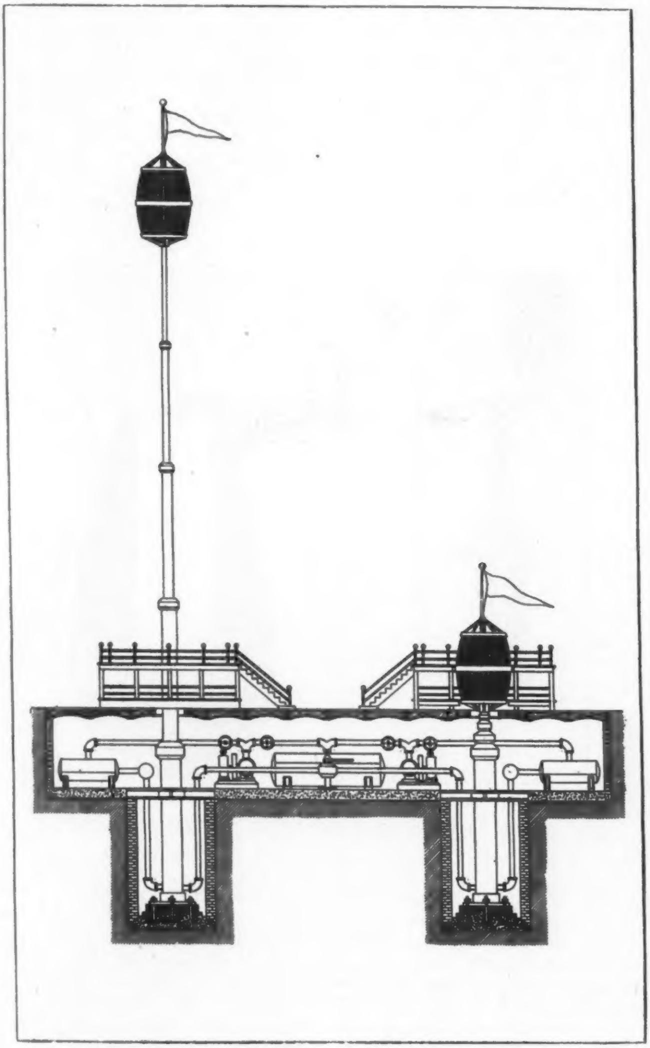
Production of ice per hour, 13.2 × 6.4 = 84.48 kilos., cost price 5 francs per 100 kilos.	4.224	fr.
Cooling the cellar, as above	3.57	"
Expenses for ice without the refrigerating installation	7.794	fr.
Cost of motive power, 13.20 × 0.32	4.224	"
Profit per hour	3.57	fr.

—the cost only of cooling the cellar without supplementary production of ice.

The comparison of these figures shows that under the most unfavorable conditions the utilization of the exhaust of a compressed air motor for cooling the cellar costs no more than ice. In proportion to the increase of the lighting capacity, there will be a larger production of ice. As this ice is stored to be used as required, there will consequently be an advantage in using the motor, as against purchasing ice at the high prices charged.

New Mechanical Amusement Device.

The accompanying illustration shows the latest adventure in the amusement line, owned and controlled by the Pneumatic Tower & Elevator Company. The towers for amusement purposes shown herewith are to be about 125 feet high and operated by compressed air, the air working on the inside of the tubes and forcing them upward telescope fashion. They will be built in pairs. This cheapens the cost of operation while doubling the capacity, as the highest tower, on coming down, forces



A NEW MECHANICAL AMUSEMENT DEVICE.

the other tower up until they are opposite, before it is necessary to apply any power. Each tower will make four trips per hour, rising alternately.

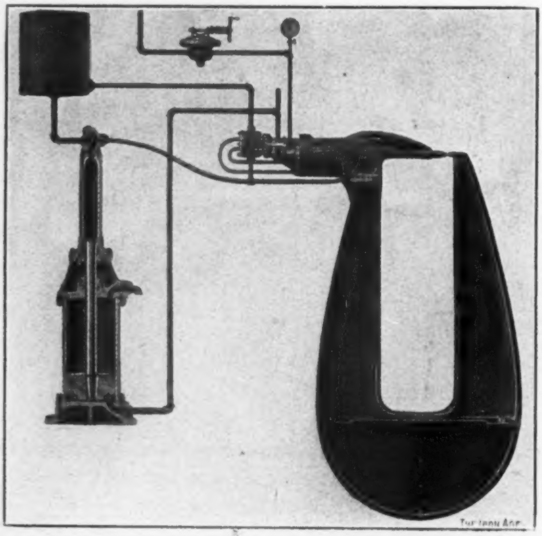
The entire operating mechanism will be under ground. The construction will be of special steel tube about ½ inch in thickness, 25 feet in length, the top tube being about 12 inches in diameter. The cage mounted on the top tube will hold 25 people, and when the tower is up will revolve on the tube so as to give occupants, who remain seated, a view of entire surroundings. The cage will be illuminated with electric lights in the evening.

At first thought the tower would seem to be unstable, but actual calculations prove it to be as safe as any skyscraper. The estimated cost is $20,000.

The design and engineering will be done by Winn, Milmoe & Porter, No. 79 Dearborn street, Chicago, and the patent rights belong to a Chicago man, who is forming a company to build and erect a number of the towers in the various amusement parks, and also to apply the same principle to passenger elevators.—*Modern Machinery.*

The Fisher Hydraulic-Pneumatic Stationary Riveter.

A new style of hydraulic riveter operated by steam or compressed air through the medium of an intensifier is being built by the Fisher Foundry and Machine Company, Pittsburgh, Pa., The intensifier consists of two cylinders, one placed above the other. The lower or larger is connected with the source of power—the air tank or steam boiler; while the upper or smaller cylinder, filled with water, is connected with the riveter cylinder. The piston rod of the lower cylinder forms the plunger



THE FISHER HYDRAULIC-PNEUMATIC STATIONARY RIVETER.

for the upper cylinder, so that when the pressure is admitted to the lower cylinder its piston rises, forcing the water from the upper cylinder into the riveter cylinder at a pressure which is increased above the pressure of the steam or air in the proportion of the areas of the intensifier, piston and plunger.

One stroke, not necessarily a full stroke, of the intensifier produces a complete cycle of operations of the riveter—to advance and secure the plate holder, in case one is used, or to advance the riveter die and

form the rivet head, and finally to return both riveter and plate holder dies to their original position.

The valve arrangement is such that these operations are controlled by one movement of each of two levers, in case the plate holder is used, and one movement of one lever in case the plate holder is omitted. The levers are returned to their original position automatically in either case.

A water tank placed at a suitable elevation is connected with both the upper intensifier cylinder and the riveter cylinder, in such a way that any waste from either cylinder is automatically supplied and the column of water from the tank to the intensifier cylinder, from the intensifier cylinder to the riveter cylinder and from the riveter cylinder back to the tank is maintained intact. Furthermore, the hydraulic head of the water in this tank is utilized in performing the idle movements of the different parts.

Between the air tank or steam boiler and the lower intensifier cylinder there is placed a regulating valve, by means of which the pressure under which the rivet is formed, and consequently the power consumed in forming the rivet, is controlled and adjusted approximately to the size of the rivet, resulting in a decided economy in power consumed.

In so far as the fluid in the riveter is used over and over again, oil or glycerine may be substituted for water, preventing freezing in cold weather and providing at the same time an efficient lubricant for all packing.—*Iron Age.*

Notes.

A compressed air house cleaning company is being organized at Oshkosh, Wis. The Thurman and Nation patents will be used.

Compressed air cleaning has been inaugurated at the Homewood barns of the Pittsburg (Pa.) street railway. Heretofore the cleaning has been done by hand. The change has given better results and greater economy.

Among the recent incorporations in the State of Kentucky was the Compressed Air Carpet Cleaning Company, of Louisville. It has a capital of $20,000, and the incorporators are C. C. Stoll, Daniel Carrell and Albert Reutlinger.

Compressed air is being used to replace steam for operating the fog horn at the light house at Cape Henry, Va. Delays of fifteen to twenty minutes were frequent, as it required that length of time to get up steam to operate the horn.

The Waukesha Compressed Air Cleaning and Painting Company has been formed at Oconomowoc, Wis., with $10,000. One purpose of this company is to rid the maple trees in that city of the dread cotton scale. It is claimed that this can only be successfully accomplished by the use of a spray operated by compressed air.

An air compressor, driven by an electric motor, has been installed to operate a fog horn at the Eastern Gap, near Toronto, Can. The great advantage of this method is its promptness of operation. In the case of the old horn at the western end of the harbor, it is necessary to get up steam before the whistle can be blown.

The General Railway Signal Company, with a capital of $5,000,000, has been formed by the consolidation of the Pneumatic Signal Company, of Rochester, N. Y., and the Taylor Signal Company, of Buffalo, N. Y. The executive offices of the company will be at Buffalo, and Wilmer W. Salmon, of that city, is the president and general manager of the new corporation.

Compressed air is reported to have made possible a visit to a dangerous valley in the mountains of Mindanao, in the Philippines. The valley is filled with a poisonous vapor which arises from the crater of an old volcano. There are rich deposits of gold there which have been out of reach. A party of Americans is reported to have taken tanks of compressed air along for breathing purposes and secured a large quantity of gold-bearing sand.

Experiments with an apparatus which forces into the breech of a gun a stream of compressed air and steam, thus syringing out the gun before another charge is inserted, are being conducted at the

Washington Navy Yard under the instructions of the United States Bureau of Ordnance. This is only one of the many devices which have been suggested to prevent flare-backs. On the "Illinois" one has been installed by which the forced draught used for the Whitehead torpedo tubes is turned into the breech of the guns at a pressure of about 100 pounds per square inch.

A Salt Lake City official has suggested a plan whereby he believes compressed air could be used very largely for irrigation purposes in the West. He says that an undershot water-wheel can be placed in the centre of a stream and that the wheel will generate power to run an air compressor. The compressed air thus obtained is to be used as power for running pumps to raise the water from the stream. The water-wheel, he says, could be placed at any point on the stream and the compressed air conveyed in pipes to the pumps. In this way it is said any amount of power could be produced and water in large quantities could be raised to any height at a very inconsiderable expense after the compressor and pumps were once installed.

After an interval of seven years from the date of the invitation of tenders, the contract for the execution of the drainage works of Oporto was given in December last to a British firm. The works comprise the complete drainage of Oporto on the separate system. The fact of the town being situated on the steep northern bank of the Douro allows of its being drained mostly by gravitation down toward the riverside. Here the sewage will be received in ejectors, worked by compressed air, and forced into a rising main, terminating in large outfall tanks built in tunnel, whence the sewage will be discharged into the Atlantic at the turn of each tide. The main works for the execution of this scheme are to be completed within four years' time.

Commissioner Woodbury, of the New York Street Cleaning Department, has made use of compressed air to render his street sprinklers more effective. The air pressure is used for forcing the water from the tank and through the sprinklers. In the smaller machines this pressure is obtained by forcing the water into the tank from the bottom with the pressure of the street hydrants, thus forming a powerful air cushion at the top of the tank. In the larger type of machine an air compressor, driven by a gasoline engine, forces air into the reservoir above the water line, giving additional pressure. These sprinklers were given a test at flushing asphalt streets and proved very successful. They are claimed to be far superior to the old method of using a stream from fire hose for street flushing.

Referring to the danger to the men in mines from the minute particles of grit in the air, which has been receiving considerable attention in England and on the Rand, the *Engineering Times* (England) says:

"There is also another trouble in connection with these gritty particles. They get into the compressors, and from there into the drills, and lead to heavy repair bills. It is now proposed to wash the air on its way to the compressor, in order to remove these particles, and for this purpose the air is drawn through a vessel containing water, being made to take a tortuous course through the vessel, by means of baffles, in the usual way, while at the entrance to the water vessel the air passes through a sort of comb, which assists in the process. The intention is to trap the dust, much in the same way that oil and water are trapped in separators for steam. After the air has passed through the water vessel it passes through a fairly long duct before being sucked into the air compressor, the object of this being to cause the water which will have come over with the air to be deposited before the air enters the compression cylinder. The plan is one which might well be adopted generally, even where grit is not feared from drills or stamps. The presence of the water cools the air and adds to the efficiency of the apparatus, and it is easy to get rid of the water afterward. There is plenty of coal dust floating in the atmosphere on colliery pit banks and the neighborhood from which the air for compression is drawn which might well be prevented from entering the air compressor, with great advantage in the matter of efficiency and in the repairs bill."

The plan has frequently been suggested, in connection with compressed air plant, of bringing the air trom the exhaust of the engines, driven by the compressed air back to the compressor, and it has many advantages. One great advantage is, the moisture which is present in the air when it enters the compressor will be got rid of, at any rate after the air has traversed the air circuit a number of times. In addition, the matter of expansion of the air, which is so troublesome where the air is simply allowed to expand into the atmosphere of the mine, should be turned to the advantge of the compression system. One of the difficulties, in connection with the efficiency of the compressed air system, is the fact that the air which is taken in the compressor is uncertain in quantity. In warm weather, or where the engine-house is warm, the air occupies a larger space than when the engine-house is not at a high temperature. When the air which is drawn into the compressor is warm, the efficiency of the system suffers, and *vice versa*. On the other hand, the expansion of the air in the cylinder of the motor, whatever the motor may be doing, lowers the temperature of the surroundings, including that of the air itself. So that if the air, which has been cooled by its own expansion within the motor cylinder and in the exhaust, can be taken back to the suction port of the compressor, the efficiency of the system should be increased. But there is the usual drawback. The greatest of all troubles with compressed air is leakage, principally in the pipes connecting the compressor with the motor; and it is only too probable that doubling the pipes would mean doubling the losses due to leakage. Economy will certainly result from the use of the exhaust air in the suction of the compressor, provided that the air is not throttled nor back pressure set up, and it will be a question whether the gain from this cause will be balanced or not by the loss from the increased length of pipes.—*Engineering Times* (Eng.).

Readers of "COMPRESSED AIR may find a recent inquiry in the *Rural New Yorker*, with the reply, of interest:

"Would it be practicable to cool water in a tank by releasing compressed air at say 150 pounds pressure into it? If so, how cool could the water be made by it?

"J. R. T., North Dartmouth, Mass.

"The expansion of compressed air always results in cooling, but the difficulty lies in devising an economical device for compressing and utilizing it afterward. The specific heat of air is .2375, hence it requires a rise in temperature of 1 degree in 1 pound, deriving its heat wholly from the water, to lower the temperature of .2375 pound of water 1 degree. When air expands, doing work only upon itself, its temperature falls 1 degree F. for each increase of 1-491 in its volume. When air is put under a pressure of 150 pounds per square inch its volume has been reduced, speaking in approximate round numbers, to 1-10. It has, therefore, been placed under conditions which enable it to expand tenfold when released. But a tenfold increase in volume would be 4,910 times the increment stated above, and if this expansion could be allowed to take place so that it simply cooled itself, it would lower its own temperature through 4,910 degrees F.

"The weight of air at mean pressure and at 62 degrees F. is 8 pounds per 100 cubic feet, and 100 cubic feet, placed under a pressure of 150 pounds per square inch, would have its volume reduced to 10 cubic feet; it could, therefore, be allowed to expand and increase its volume 4,910 times the increment which will cool itself 1 degree F. Its cooling effect, could it be imparted wholly to 100 pounds of water, would be capable of lowering the temperature of this amount of water 93.29 degrees F., and of cooling 1,000 pounds of water through 9.3 degrees F. It has not been found practicable, however, so far as the writer knows, to devise a suitable mechanism for compressing air, wasting the heat of compression, and then economically utilizing the compressed air to produce refrigeration simply.

"F. H. KING."

A scheme for the distribution of parcels, etc., through pneumatic tubes, has been under the consideration of the Post Office authorities for some time, but without material progress being made, and the owners of the patent rights have therefore decided to go to Parliament for power to apply the system in the metropolis, probably under license of the Postmaster-General, the present idea being to embrace the city and most of the leading suburbs. This will necessitate 95 miles of double tubing, which, with the necessary power

plant, will involve a capital expenditure of three millions sterling. Hitherto the pneumatic system has been used in this country only for the distribution of telegrams, but in the States there are in most cities parcel delivery systems, the greatest distance of pneumatic distribution being 4 miles. It is proposed to limit the size of piping to 12 inches, which represents also the diameter of the cylindrical carrier. This latter is of steel, riveted, with doors at each end having an effective locking arrangement. The whole system was shown at work on the 28th ultimo on a large scale at the works of the company at Putney, and live chickens, cardboard boxes of eggs, bottles and other breakable material were transferred at a speed of 40 miles an hour without injury. The carriers, of various length, are driven through the tubing by air, the pressure varying according to the weight of the carrier from 2 pounds to 10 pounds per square inch; but at sub-stations, at half-mile intervals, there will be an automatic arrangement for renewing the pressure. At sub-delivery stations there is also an ingenious arrangement, controlled by electric mechanism, whereby a carrier is shunted into a siding in the tube if its contents are for that particular station, other carriers passing on. The electric mechanism is operated in such case by a disc on the front of the carrier corresponding exactly with an electric contact breaker, so that each carrier has its own open sesame to its own junction. The prevention of shock at the delivery end is another well-conceived piece of mechanism—the air in front of the carrier is necessarily compressed as the carrier nears the end of its journey, and the compression of this air is utilized to operate gear for obviating shock.—*The Practical Engineer* (Eng.).

In the early part of 1897 an effort was made to find out the actual costs of upkeep of a machine placed in the hands of competent miners and subject to special supervision. The machine was specially prepared before being sent underground, the cylinder being very carefully bored out to insure a glassy-like surface inside and to make it perfectly parallel. A special piston, made from high carbon steel, was made and ground into the cylinder, great care being taken to insure the tightest possible working fit; all of the piston was made dead hard, except the chuck-rod and chuck, a special arrangement being provided on one of the lathes to grind the piston down to the required size. A special valve of tool steel was formed and fitted to the valve chest, after it had been carefully bored out, the same precautions being taken to insure a good tight fit, as in the case of the piston and cylinder. The remaining portions of the machine received very careful attention, and everything possible was done to insure the machine being in perfect order.

The machine ran fourteen months, double shift, in the hands of the same men, with the exception of four occasions, when it was in the shops for extensive overhaul of cradle and front-head; on each occasion it was laid aside twenty-four hours. During the entire period under observation there were four new valves fitted, nine chuck-bolts, eleven chuck-bushes, six rotating nuts, twelve sets ratchet pawls and springs, three feed-screws, three feed-nuts, six sets front-head bushings; no work was done on the piston proper. So pleased were the men with the performance of the machines that they preferred to lie off during the periods referred to rather than handle another machine. The costs might have been followed up for a longer period, but unfortunately the machine got injured, due to blasting. On being brought to the surface, the wear between the cylinder and piston amounted to 16-100ths of an inch, as measured by the micrometer. The following were the costs:

Machine repairs at start....	£15	0	0
Eleven chuck bushes, at 12s.	6	12	0
Nine chuck bolts, at 4s. 9d..	2	2	9
Four new piston valves, including reaming chest....	4	15	0
Six rotating nuts at 12s. 6d.	3	18	0
Twelve sets ratchet pawls, at 9s.	5	8	0
Three feed screws at 21s...	3	3	0
Three feed nuts, at 21s.....	3	3	0
Six sets front head bushings and leathers, at 20s.......	6	0	0
Labor	26	0	0
Allowance for mechanical power	17	10	0
Supervision, office charges, etc.	14	0	0
	£107	11	9

Equal to £7 13s. 8d. per month.

The approximate footage drilled was 13,104 feet.—*South African Mines.*

Compressed air or steam, through the medium of an intensifier, is used to operate the Fischer hydraulic-pneumatic riveter.

The intensifier consists of two cylinders, one placed above the other. The lower or larger cylinder is connected with the source of power, the air tank or steam boiler, while the upper or smaller cylinder filled with water is connected with the riveter cylinder. The piston rod of the lower cylinder forms the plunger for the upper cylinders, so that when the pressure is admitted to the lower cylinder its piston rises, forcing the water from the upper cylinder into the riveter cylinder at a pressure which is increased above the pressure of the steam or air in the proportion of the areas of the intensifier, piston and plunger.

One stroke, not necessarily a full stroke, of the intensifier produces a complete cycle of operations of the riveter, namely: To advance and secure the plate holder, in case one is used; to advance the riveter die and form the rivet head, and finally to return both riveter and plate holder dies to their original position.

The valve arrangement is such that these operations are controlled by one movement of each of two levers, in case the plateholder is used, and one movement of one lever, in case the plate holder is omitted. The levers are returned to their original position automatically in either case.

A water tank at a suitable elevation is connected with both the upper intensifier cylinder and the riveter cylinder, in such a way that any waste from either cylinder is automatically supplied and the column of water from the tank to the intensifier cylinder, from the intensifier cylinder to the riveter cylinder and from the riveter cylinder back to the tank, is maintained intact. Further, the hydraulic head of the water in this tank is utilized in performing the idle movements of the different parts.

Between the air tank or steam boiler and the lower intensifier cylinder there is placed a regulating valve by means of which the pressure under which the rivet is formed and consequently the power consumed in forming the rivet is controlled and adjusted approximately to the size of the rivet, resulting in economy in power consumed. In so far as the fluid in the riveter is used over and over again oil or glycerine may be substituted for water, preventing freezing in cold weather and providing at the same time an efficient lubricant for all packing.

By the use of a single riveting cylinder any pressure between maximum and minimum can be secured instantly by adjusting the hand wheel on the regulating valve. This eliminates a large number of details with the attendant expense of maintenance. Another advantage is that the power consumed is directly in proportion to the size of the rivet driven. The riveter with its intensifier constitutes a complete installation exclusive of pumps, accumulators and the more or less extensive hydraulic installation.

These riveters are built by the Fischer Foundry and Machine Company, of Pittsburg.

L'Ingenieur contains the following query and answer:

"W. H. B. (Measham) writes—A scheme has been suggested by which compressed air (obtained by hydraulic power) is to be supplied at 60 pounds pressure for working rock drills. The supply of water is abundant, with 200 feet head. The water will be conducted in pipes to air receivers and run until the desired pressure is gained. An alternative method, with possibly better results, is to bring the water direct to a hydraulic boring machine. Please advise.

"Air can be compressed in the manner suggested by the querist by means of two iron cylinders, which are connected together with a pipe that is furnished with a check valve; one of the cylinders (the receiver) will receive the air that is compressed by the water in the other cylinder. This latter cylinder must be connected to the water supply pipe, which is taken down the centre of the cylinder nearly to the bottom, and the compressed air outlet placed at the top. An air inlet must also be placed at the top of this cylinder, with a valve opening inward, a sluice valve on the water supply pipe, and a valve on the water outlet, from which the spent water is discharged, at the bottom of the cylinder. A water-gauge glass to show when the cylinder is full of water may be fixed near the top of the compressing cylinder. When the cylinder is full of water the supply is shut off and the outlet through which the spent water runs to waste is opened; air at atmospheric pressure then enters through the air inlet and the cylin-

der is ready for another compression. The cycle of operation described above may be continued as long as the drill is in use; or the receiver, if of sufficient capacity, may be filled to the terminal pressure (which will be about equal to the pressure of the head of water), and may be used as required until the pressure falls to about 60 pounds per square inch. But in order that the pressure may be constant at the drill, the air from the receiver must pass through a pressure regulating valve. Data for calculating the size of a cylinder that may be charged and used as suggested are given below. A head of 200 feet is equal to a pressure of 86.5 pounds per square inch; 1 pound of air at a temperature of 32 degrees occupies, at atmospheric pressure, a space of 12.39 cubic feet, and at a pressure of 86 pounds per square inch (and at the same temperature) occupies a space of 2.15 cubic feet (approximately). A great advantage in the system as suggested for air compression, employing the water direct for compressing, is that the compression will be nearly isothermal, and will, therefore, be effected at less cost of energy than when a dry compressor is employed. Or the water could be used for working a turbine or Pelton wheel which would drive an ordinary compressor. The compressed air system of working the drills is in several ways far preferable to the hydraulic system; for example, when air is used, the exhaust will be useful in keeping up a good ventilation, especially in the case of long workings underground. A disadvantage of the hydraulic system is that the exhaust water must be conveyed away from the working, and the only possible method of conveyance may be an expensive one."

Air brakes have come naturally to be considered a necessity on heavy interurban cars. On single-truck city cars they have made very little headway. When it comes to double-truck city cars, however, there is a contested territory where there is considerable difference both in practice and opinion. Many companies are operating double-truck city cars with hand brakes, while others are using air brakes for the same weight of car. The question is, perhaps, too often considered simply as one of cost of brake maintenance. If that is the only thing to be considered there is no doubt that the hand brake is the most economical. Some managers object to the air brake because they say that with the additional complication it involves it is not, on the whole, as reliable as the hand brake, and that with the class of labor employed it is less likely to prove reliable. This, however, is simply another way of putting the argument that the cost of maintenance of the air brake is greater than of the hand brake. It is known from experience with air brakes on heavy cars that they can be maintained so as to give good and reliable service if the proper attention is given to maintain them in reliable condition. It is, therefore, simply a question of cost of maintenance after all, as by spending enough money on maintenance the air brake can be made reliable. The whole thing simmers down, then, to whether it pays to spend this money in maintenance for the benefits received from the air brakes.

The greatest benefit which is supposed to be obtained from the use of air brakes is the reduction of accidents. That air brakes save some accidents there is no doubt, but like every other safety appliance their value in that respect, however great, is largely a matter of guess work. While this is important, it is not the only advantage of air brakes. There are other points to be gained by their use as compared to hand brakes, which are susceptible of fairly definite engineering determination, and it is to these points that we wish especially to call attention here in the hope that the city railways that are now adopting air brakes may be induced to determine for their own benefit, and that of the art in general, how much these points amount to.

It has been claimed that with cars operating over the same route on a given schedule less energy in kilowatt-hours per car mile will be required than with hand brakes. This would apparently be true for two reasons. Since the air brakes are applied more quickly and easily than the hand brakes, a motorman will naturally drift with current off more with the air brake than with the hand brake. When, with the air brake, he would apply the brake suddenly and make a quick stop, he would apply it slowly by hand, and hence could not coast as much to make the same schedule with the hand as with the air brake. Further than this a motorman is tempted to run with the brakes partly set, or at least with the slack all taken up

when in a crowded street with a hand-braked car, because of the necessity of being prepared to stop quickly. We see here two reasons for increased economy with air brakes. Informal tests that we have heard of would seem to indicate that these things work out in practice as expected, but a determination of how much this saving of energy will amount to in a given case would be valuable.

Another point in favor of the air brake that has a commercial value aside from the saving of accidents is that they make possible a faster schedule without increased risk. We have in mind one case where the introduction of air brakes in city service had the effect of changing what was apparently a very fast schedule and one hard to maintain into one with which there was no trouble in being on time. —*Street Railway Journal.*

The following letter recently published in the *Engineering News* may be of interest:

"Sir—Having charge of a large air plant, I noted with interest a recent article in your editorial columns in regard to air supply for forges from a compressed-air plant of high pressure, and although I am without data of any value, I do not accept as proven that a jet of compressed air impinging on the back of the blades of a fan will deliver a larger volume of air at a suitable pressure than if used in what you term an ejector.

"If I understand your term, an ejector is a jet of high pressure air through an opening of considerably greater area, by which means a large volume of atmospheric air is induced, mixed and discharged with the jet. I have looked in vain for any reliable data regarding volume and pressure under these conditions, but have had in use for nearly a year a device of this kind; that, with less than 7 cubic feet of air (by table in Hiscox's "Compressed Air") at 100 pounds pressure, operates rivet forges much more satisfactorily than was previously done with a direct blast of compressed air from which the atmosphere was excluded. I have had another device (maker unknown) which admitted compressed air through an annular opening around a tube about ⅜ inch diameter. This gave a pretty high pressure, but was deficient in volume for the required purpose. The ejector blowers which I now use have a nozzle opening made with a No. 52 twist drill, flared slightly at the outer end and discharging into a hollow frustum with an opening 1¼ inches in diameter at the small end; the end of the nozzle being about 3 inches back from the opening and in line with the centre.

"I have found that a straight tube extending 3 or 4 inches from, and of the same diameter as, the small end of the frustum, increases the efficiency, but have not been able to determine to what extent.

"I have recently by another device applied to heavy forges, raised to a welding heat a bar of 4-inch iron in less than 18 minutes, with an estimated expenditure of 38 feet of air per minute at 100 pounds (by table as before). I have not applied such a device behind the blades of a fan, though if that should be done, and the fan then takes in air, it would certainly go far toward proving the efficacy of an air jet applied in that way; but the result of such few experiments as I have been able to make, inclines me to the belief that more can be obtained from compressed air by induction than by actuating machinery with it for the purpose under discussion.

"I have found that very slight differences of size and form make wide differences in the results, and estimating consumption from tables and formulæ is quite another matter from measuring actual volumes. I would like to know if any of your correspondents have any reliable means of measuring air volumes at or near atmospheric pressure, at a reasonable cost.

"My experiments show that the induction of air is a wide and promising field for investigation, and I believe in the possibility of valuable devices for producing lower pressures by other means than reducing valves, in which the difference of pressure is a dead loss.

"Sand blasts, pneumatic painting machines, and other devices of that class ought to be operated in such a way as to return at least a portion of the surplus energy by inducing air at the required pressures, and may it not be possible that stored pneumatic power at higher pressures would yield greater efficiency if handled in the same manner?

"Yours respectfully,

"Edmund Hoxie,

"78 Clinton St., Everett, Mass., May 16, 1904."

INDEX.

U.S. PATENTS GRANTED JULY, 1904.

Specially prepared for COMPRESSED AIR.

763,964. SAFETY TRAIN-CONTROLLING SYSTEM. George W. Cohen, Allegheny, Pa., assignor to the Cohen Automatic Electric Block Signal Company, a Corporation of New Jersey. Filed Oct. 1, 1903. Serial No. 175,255.

764,004. AIR-HEATER. Willis J. Perkins, Grand Rapids, Mich. Filed May 18, 1903. Serial No. 157,593.

764,131. PNEUMATIC-TIRE VALVE. John E. Keller, Jr., Litchfield, Conn. Filed Sept. 8, 1903. Serial No. 172,397.

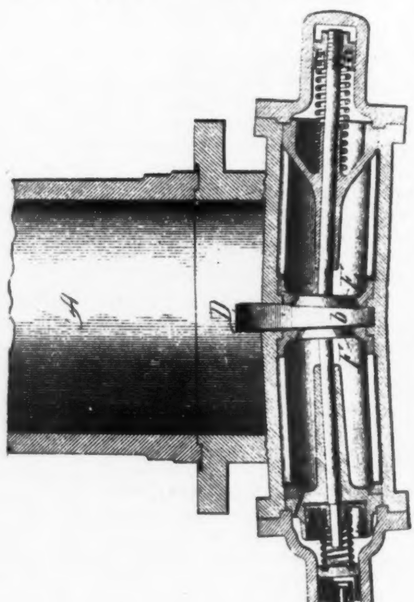
764,142. AUTOMATIC AIR-BRAKE. Harry McCleary, San Juan, Porto Rico. Filed Nov. 21, 1903. Serial No. 182,133.

764,186. GAS-PRESSURE REGULATOR. Robert A. Gillespie, Allegheny, Pa., assignor to Gillespie Manufacturing Company, Allegheny, Pa., a Corporation of Pennsylvania. Filed Dec. 10, 1903. Serial No. 184,543.

764,217. AIR-BRAKE SYSTEM FOR RAILWAY TRAINS. Nelson M. Tiffany, Syracuse, N. Y. Filed July 13, 1903. Serial No. 165,277.

764,555. MEANS FOR CONTROLLING THE PAPER-WINDING MECHANISM OF AUTOMATIC MUSICAL INSTRUMENTS. Theodore P. Brown, Worcester, Mass., assignor to Simplex Piano Player Company, Worcester, Mass., a Corporation of Massachusetts. Filed Feb. 17, 1902. Serial No. 94,353.

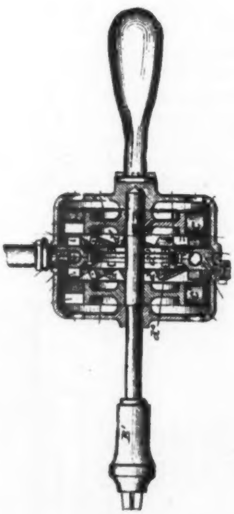
764,182. AIR-COMPRESSOR. Charles J. Diedrich and Anthony F. Cramer, Detroit, Mich. Filed Sept. 24, 1903. Serial No. 174,437.



A compressor, the combination with the cylinder, of a chamber exterior to and extending transversely across the base of the cylinder proper and containing converging valve-seats forming between them a tapering pocket leading to a port through which said chamber communicates with the cylinder, a spring-pressed suction-valve in said

chamber at one of said seats, and a spring-pressed delivery-valve in said chamber at the other of said seats.

764,498. PNEUMATIC TOOL. Charles C. Poole, Evanston, Ill., assignor to Melville E. Dayton, Washington, D. C. Filed Apr. 2, 1903. Serial No. 150,723.



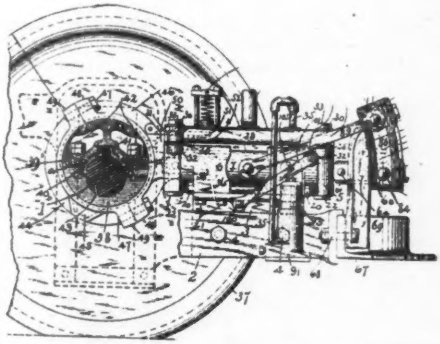
A pneumatic tool comprising a stock, a rotative tool-actuating spindle mounted on the stock and a pneumatic motor embracing a rotative disk, which is mounted on the stock concentrically with the said spindle and having driving connection therewith, said disk being provided with radial buckets having concave working faces and an annular fixed air-tube mounted on the stock concentrically with said disk at one side of and out of contact with said buckets, said air-tube being provided with an annularly-arranged series of jet-openings arranged obliquely to the longitudinal axis of the tube and directed toward the concave faces of said buckets.

An annular air-tube for pneumatic motors provided in each of its opposite sides with a series of oblique jet-openings and with a series of transverse, oblique, flat walls through which the jet-orifices severally extend and which are perpendicular to the central axes of the jet-openings, said tube consisting of two separate parts or sections, which are divided longitudinally between the sets of jet-openings and are permanently joined to each other.

764,596. HIGH-SPEED PRESSURE-REDUCING VALVE. Geo. W. Kaiser, Wilmerding, Pa., assignor to The Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Jan. 9, 1903. Serial No. 138,364.

764,597. PRESSURE-REDUCING VALVE FOR AIR-BRAKES. George W. Kaiser, Wilmerding, Pa., assignor to The Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Nov. 19, 1903. Serial No. 181,830.

764,630. AIR-COMPRESSOR. Louis T. Pyott, Philadelphia, Pa., assignor to John E. Reyburn, Philadelphia, Pa. Filed Nov. 9, 1900. Renewed Dec. 7, 1903. Serial No. 184,230.



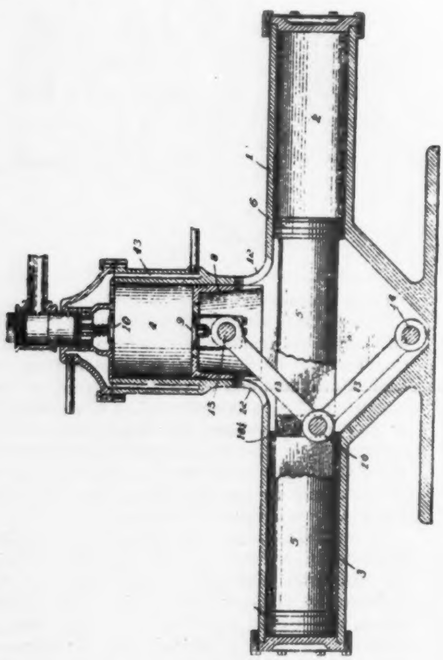
An air-brake compressor, plural tandem cylinders for compression, and supported upon a truck-frame, a piston within each cylinder, an eccentric fixed upon the truck-axle, means to connect the eccentrics to the pistons at a point between the tandem cylinders and in manner to graduate the movement of the pistons according to an increase or decrease of pressure and to stop the pistons irrespective of the movement of the eccentric when they have compressed a maximum fixed pressure, and to put the pistons into operative action when a decrease of pressure takes place.

An air-brake compressor, a truck-frame, tandem single-acting cylinders thereon, a piston within the cylinders, inlet and outlet valves for the cylinders, a chamber connected to the outlet-valves, and means therefrom to connect with a receiver; an axle, a divided eccentric thereon, secured to revolve with the axle, a strap on the eccentric, double rectangular section-rods secured to the strap and having a journal-boss similarly secured to their outer ends; a rocker pivotally suspended to the truck-frame, an arm on the

rocker having means to engage the eccentric-rod journal-boss; a radial and open-spaced arm on the rocker, a block adapted to move within the open space; double rods connected thereto at one end and at their other end to the piston aforesaid; a governor-cylinder, a piston within the cylinder, a connection for fluid flowing from the chamber to the cylinder, below its piston, and means operated by the piston to regulate the block in position in the open arm to an operative position by the gravity of the piston and its attached and co-operative parts, and into an inoperative position by pressure under the piston aforesaid.

764,685. AIR-BRAKE. Frank S. Sheffler, Newcastle, Pa., assignor of one-half to Walter S. Reynolds, Newcastle, Pa. Filed Jan. 25, 1904. Serial No. 190,579.

764,706. AIR OR GAS COMPRESSOR. John Braunwalder, Chicago, Ill. Filed Jan. 22, 1903. Serial No. 140,066.

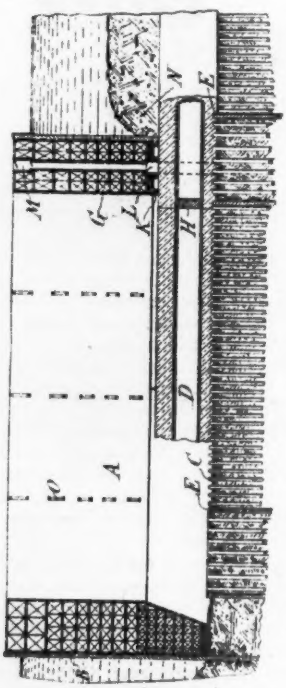


A device of the kind described, an air-chamber provided with a piston, and valves for controlling the admission and ejection of air therefrom, in combination with a cylinder provided with a reciprocating piston and a toggle-lever connected at one end to the air-piston, at its opposite end to a fixed point, and having its knuckle connected to the reciprocating piston.

764,671. PNEUMATIC GRADING OR SEPARATING SYSTEM. William S. Osborne, St. Louis, Mo. Filed Nov. 7, 1903. Serial No. 180,174.

A separating system, the combination of a current-creating device, a casing constituting an endless air-trunk returning the current to said device, means for feeding the material through the air-current to separate the dust therefrom, an air-filter open to atmosphere, and a passage tapping the air-trunk and leading to the filter, whereby a part of the dust-laden air is conducted into the filter; substantially as described.

764,797. TUNNEL OR LIKE CONSTRUCTION. Emil Diebitsch, New York, N. Y. Filed Oct. 5, 1903. Serial No. 175,904.



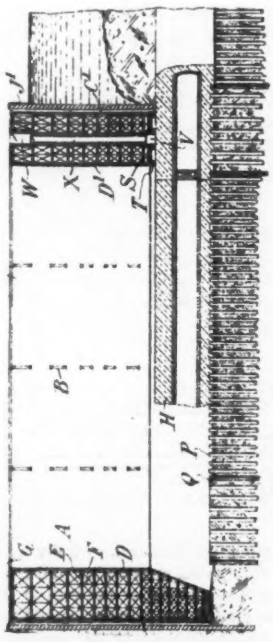
In the building of a submarine tunnel or the like, the process which consists in building a section of the tunnel, sinking a caisson at the

end of said section with one end of the caisson overlying the end of the completed tunnel section, excluding the water by air-pressure around the end of the tunnel-section, and building a second section of the tunnel in said caisson and connected to the first section.

764,739. CARPET-RENOVATING APPARATUS. William H. Loomis, Alameda, Cal. Filed June 11, 1903. Serial No. 161,023.

A carpet-renovating apparatus, the combination of a casing covering a section of carpet on the floor, mechanical means for elevating the carpet clear of the floor, a dust-dislodging device arranged to operate on the elevated portion of the carpet, and air-exhausting means connected to the casing for carrying off the dust, substantially as set forth.

764,798. APPARATUS FOR BUILDING TUNNELS OR THE LIKE. Emil Diebitsch, New York, N. Y. Filed Oct. 17, 1903. Serial No. 177,427.



In combination, an open caisson adapted to overlie a structure, and means permitting the maintenance of a pressure of air between said structure and the adjacent portion of the caisson to form in effect a pneumatic packing.

764,821. AIR-PUMP. Hubert J. Rock, Milwaukee, Wis. Filed Dec. 7, 1903. Serial No. 184,036.

A pump, the combination of concentric stationary cylinders; a tubular piston-rod arranged to reciprocate in the annular space between said cylinders, and provided with a piston fitting said space and having a valved passage leading to the interior of the piston-rod; a stationary piston fitting the piston-rod; said piston being connected with the inner cylinder and provided with a valved passage leading to the interior of the inner cylinder.

764,936. PNEUMATIC TIRE. Harry G. Fitler, Philadelphia, Pa., assignor to the Goodyear Tire & Rubber Company, Akron, Ohio. Filed Nov. 28, 1903. Serial No. 182,963.

765,008. DEVICE FOR AUTOMATICALLY OPERATING AIR-BRAKES. Theodore H. Hillman, Spooner, Wis. Filed Mar. 18, 1904. Serial No. 198,806.

765,022. RECEPTACLE FOR STORING COMPRESSED AIR OR GASES. Max Loewenstein and Jonas Stork, Brussels, Belgium; said Loewenstein assignor to said Stork. Filed July 1, 1903. Serial No. 163,923.

A receptacle for compressed gases, the combination with the receptacle, of a plug forming one end thereof, and having an outlet therethrough and externally threaded, a cap adapted to engage with said threaded plug and having an externally-threaded projection thereon and a conical recess therein, a valve engaging with said recess and having a stem projecting through a hole in said threaded projection, and a connecting-nozzle having a threaded end adapted to engage with said threaded extension on said cap, and having an internal shoulder adapted to engage with the valve-stem for opening said valve.

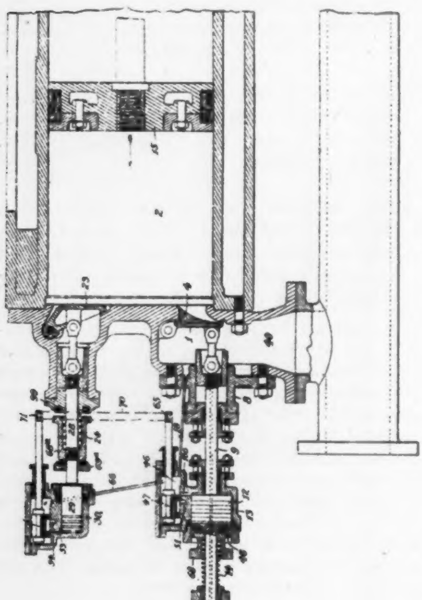
765,134. SPRAYING DEVICE. Ernest B. Freeman, Middleport, N. Y. Filed Sept. 3, 1903. Serial No. 171,779.

765,240. TUNE-SHEET ATTACHMENT FOR AUTOPNEUMATIC PIANOS. Adam Hobart, St. Johnsville, N. Y., assignor to Roth and Englehart, New York, N. Y., a Firm. Filed May 21, 1904. Serial No. 209,008.

765,263. ELECTRO FLUID-PRESSURE SWITCHING MECHANISM. Walter J. Bell, Los Angeles, Cal., assignor of one-half to Leon F. Moss, Los Angeles, Cal. Filed July 25, 1903. Serial No. 166,953.

765,270. AIR-GUN. William J. Burrows, Plymouth, Mich., assignor to Daisy Manufacturing Company, Plymouth, Mich., a Corporation of Michigan. Filed Feb. 3, 1903. Serial No. 141,680.

765,359. VALVE MECHANISM FOR AIR-COMPRESSORS OR THE LIKE. Albert W. Daw and Zacharias W. Daw, London, England. Filed July 7, 1902. Serial No. 114,644.



765,403. MEANS FOR SHIFTING THE TUBES OF PNEUMATIC STRAW-STACKERS OR OTHER PURPOSES. Frank C. Stuckel, Racine, Wis., assignor to J. I. Case Threshing Machine Company, Racine, Wis., a Corporation. Filed Sept. 23, 1903. Serial No. 174,267.

765,547. APPARATUS FOR HEATING AIR. Franklin T. Brenner, Quincy, Ill. Filed Aug. 8, 1903. Renewed May 31, 1904. Serial No. 210,408.

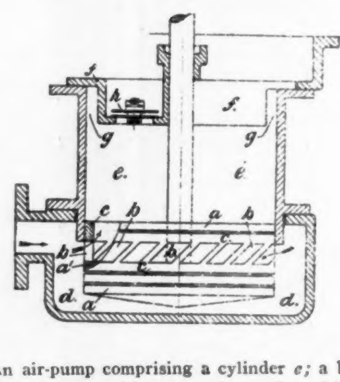
765,657. ALARM FOR PNEUMATIC FEEDERS. Thomas J. Arnault, Everett, Wash. Filed Oct. 22, 1903. Serial No. 178,083.

765,670. DOUBLE-TUBE PNEUMATIC TIRE. Arthur H. Marks, Akron, Ohio, assignor to the Diamond Rubber Company, Akron, Ohio, a Corporation of West Virginia. Filed Mar. 3, 1904. Serial No. 196,377.

765,743. MEANS FOR OPERATING PNEUMATIC VALVES. William Lintern, Westpark, Ohio. Filed Mar. 28, 1904. Serial No. 200,331.

765,849. FLUID-PRESSURE REGULATOR. Ansel L. Merrill, Hydepark, Mass., assignor of one-half to Oliver A. Miller, Brockton, Mass. Filed Sept. 12, 1903. Serial No. 172,988.

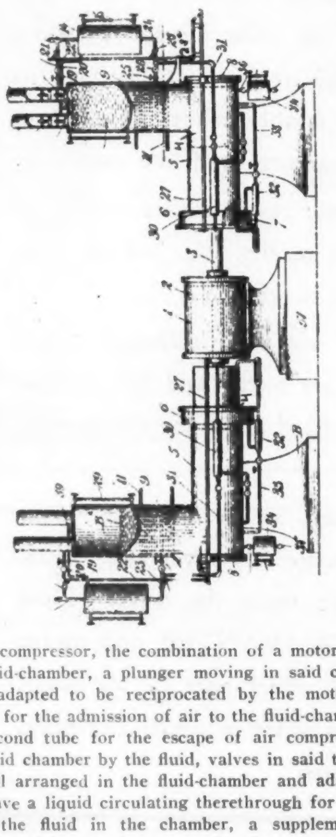
765,923. AIR-COMPRESSOR. John S. Herriot, Liverpool, England. Filed Oct. 13, 1903. Serial No. 176,931.



An air-pump comprising a cylinder *e*; a bucket of dished form, with an annular wall *c* with apertures *b* therein, adapted at the end of the stroke to pass the end of the cylinder *e*; and an end on said cylinder projecting into the same and having an annular space *g* round it; substantially as set forth.

765,929. STEAM-HEAD FOR AIR-PUMPS. John C. Lyons, McComb, Miss., assignor of one-half to T. M. Flynn, McComb, Miss. Filed Apr. 11, 1904. Serial No. 202,632.

766,017. COMPRESSOR. Ivan Carlier, Denver, Colo. Filed Feb. 4, 1903. Serial No. 141,806.



A compressor, the combination of a motor and a fluid-chamber, a plunger moving in said chamber adapted to be reciprocated by the motor, a tube for the admission of air to the fluid-chamber, a second tube for the escape of air compressed in said chamber by the fluid, valves in said tubes, a coil arranged in the fluid-chamber and adapted to have a liquid circulating therethrough for cooling the fluid in the chamber, a supplemental fluid-receiving tank arranged adjacent to the chamber, pipes connecting the said supplemental tank with the air-discharge tube and with the fluid-chamber, valves in said pipe, and means, including a rod, movable vertically at predetermined times, for controlling said valves, substantially as set forth.

766,088. AIR-BRAKE SYSTEM. William Williams, Huntingdon, Pa. Filed Mar. 24, 1903. Serial No. 149,365.